135

RFI Work Plan for Operable Unit 1154

Environmental Restoration Program

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Executive Summary

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Purpose

The primary purpose of this Resource Conservation and Recovery Act (RCRA) facility investigation (RFI) work plan is to determine whether a release of hazardous wastes or hazardous waste constituents has occurred and, if so, the nature and extent of those releases from potential release sites (PRSs) in Operable Unit (OU) 1154. This information will be used to determine the need for proceeding with a corrective measures study (CMS), the next step in the corrective action process, or to determine the need for other further action. This work plan covers OU 1154, which includes Technical Area (TA) -57. This TA is located on the western edge of the rim of the Valles caldera at Fenton Hill, 37 miles west of the Laboratory. Access to Fenton Hill is by New Mexico State Roads 501, 4, and 126. Technical Area 57, often referred to as the Fenton Hill site, is on land leased by the Department of Energy (DOE) from the United States (U.S.) Forest Service.

Module VIII of the RCRA permit, known as the Hazardous and Solid Waste Amendments (HSWA) Module (the portion of the permit that responds to the requirements of the HSWA), was issued by the Environmental Protection Agency (EPA) to address potential corrective action requirements for solid waste management units (SWMUs) at the Los Alamos National Laboratory (the Laboratory). The sites in this work plan are not identified in the HSWA Module and are outside the regulatory scope of the permit. These sites are addressed in this work plan in the same manner as the HSWA sites to ensure that potential environmental problems influenced by Laboratory operations are investigated and to present to the public and the regulators a unified plan that addresses potential environmental problems under current Laboratory jurisdiction. Inclusion of these sites in this work plan does not confer additional responsibility or authority for these sites to the regulators and does not bind the Laboratory to additional commitments outside the scope of the permit. The Laboratory will consider all comments received on this work plan. A potential release site that does not meet HSWA module definitions of a SWMU is designated by the Laboraory as an area of concern (AOC). These sites may contain radioactive materials and other substances not addressed by RCRA. The term potential release site (PRS) is the collective name for SWMUs and AOCs and will be used throughout this work plan.

Installation Work Plan

The HSWA Module requires the Laboratory to prepare an installation work plan (IWP) to describe the Laboratory-wide system for accomplishing the RFIs, CMSs, and implementation of corrective measures. This requirement was satisfied by the Installation Work Plan for Environmental Restoration submitted to the EPA in November 1990. That document is updated annually, and the most recent revision was published in November 1993. The IWP identifies the Laboratory's PRSs, describes their aggregation into 24 OUs, and presents the Laboratory's overall management plan and technical approach for meeting the corrective action requirements of the HSWA Module. When information relevant to this work plan has already been provided in the IWP, the reader is referred to the 1993 version of that document.

OU 1154 Background

The Laboratory has conducted research activities within OU 1154 since 1974 in the development of hot dry rock geothermal energy. The principal activities were drilling deep boreholes into the earth, circulating water though those boreholes to extract geothermal energy, and seismic monitoring and environmental surveillance in support of these research activities. Preliminary investigations of the OU conducted in 1987 revealed eight PRSs that warranted more detailed investigation. Two additional PRSs have been identified after further investigation of the site. This plan combines the PRSs into five groups: the drilling mud pits, the settling pond system, the sludge pit, chemical waste disposal areas, and a waste container storage facility. Each group has different characteristics, and some have been remediated or partially remediated as part of site operations.

Technical Approach

This work plan presents the description and operating history of each PRS together with an evaluation of the existing data, if any, in order to develop a preliminary conceptual exposure model for the site. For some sites, no further action can be proposed on the basis of this review; these sites are discussed in Chapter 6. The remaining sites are discussed in Chapter 5. For some currently active sites, this review was sufficient to determine that investigation and remediation (if required) may be deferred until the site is decommissioned. RFI field work and/or voluntary corrective actions (VCAs) are proposed for the remaining sites.

The technical approach to field sampling followed in this work plan is designed to refine the conceptual exposure models for the PRSs to a level of detail sufficient for baseline risk assessment and the evaluation of remedial alternatives (including VCAs). A phased approach to the RFI is used to ensure that any environmental impacts associated with past and present activities are investigated in a manner that is both cost-effective and complies with the HSWA Module. This phased approach permits intermediate data evaluation, with opportunities for additional sampling, if required.

For PRSs for which there are no existing data and little or no historical evidence that a release has occurred, the Phase I sampling strategy for OU 1154 will focus on determining whether a release has occurred based on the presence or absence of hazardous and radioactive contaminants. If contaminants are detected at concentrations above background levels and conservative screening action levels (SALs), a baseline risk assessment may be required, or a VCA may be proposed. Screening action levels are conservative guidelines based on risk assessment, for soil, water, and air, that indicate potentially hazardous contaminant levels. If conducted, the baseline risk assessment will be used to determine the need for further corrective action. If the data collected during Phase I are insufficient to support a baseline risk assessment, additional RFI Phase II sampling will be undertaken to characterize in more detail the nature and extent of the release.

Data quality objectives to support the required decisions are developed for RFI Phase I sampling and analysis plans described in this work plan to ensure that the right type, amount, and quality of data are collected. Field work for many sites includes field surveys and field screening of samples on which the selection of samples for laboratory analysis will be based. Laboratory analyses will be performed in mobile and fixed analytical laboratories.

The body of the text in this work plan is followed by five annexes, which consist of project plans corresponding to the program plans in the IWP: project management, quality assurance, health and safety, records management, and public involvement.

Schedule, Costs, and Reports

Timely completion of the work outlined in this RFI work plan depends on timely and complete distribution of funds appropriated by Congress for environmental restoration. Sufficient funding through the DOE budgetary process to fulfill DOE obligations arising under this submittal will be sought, except when the obligation or payment of funds is interpreted to be in violation of the Anti-Deficiency Act, 31 U.S.C. §1341 et seq. In cases where the payment or obligation of funds constitutes a violation of the Anti-Deficiency Act, the schedule dates established requiring the payment or obligation of such funds shall be appropriately adjusted. However, should the ER appropriation be inadequate in any year to meet the total DOE implementation requirements, the DOE shall follow a standardized DOE prioritization process that allocates that year's ER appropriations in a manner that maximizes the protection of human health and the environment. A standardized DOE prioritization model is being developed and will be used with the assistance of the EPA and the State of New Mexico Environment Department (NMED).

The RFI Phase I field work described in this document will require almost 1 year to complete (see Figure ES-1). A second phase of field work will occur if warranted by the results of the first phase. If deemed necessary, the second phase of field work would be conducted in fiscal year 1996.

Cost estimates for baseline activities for OU 1154 are provided in Table ES-1. The costs are based upon assumptions that are generic to the Program and are, therefore, only approximate. The costs are based on past experience when applicable and are estimated in other instances. The estimated cost for implementing the RFI and reporting is almost $3.7 million. This would include any necessary remediation by performing VCAs. Based on knowledge to date, a CMS will probably not be necessary. However, if it is determined that a CMS will be necessary, the estimated cost for the corrective action process will increase accordingly.

Monthly reports and quarterly technical progress reports will be submitted to the appropriate regulatory agencies. In addition, RFI phase reports will be submitted at the completion of each of the sampling events. The RFI phase reports will serve as

ACTIVITY	EARLY START	EARLY FINISH
1154: ADS Management Assessement (LOE)	01 OCT 92	13 NOV 97
1154: RFI Work Plan	01 OCT 92	10 NOV 94
1154: RFI Field Work	24 MAY 94	06 OCT 95
Phase I	24 MAY 94	25 AUG 94
Data Assessment Phase I	14 JUL 94	22 FEB 95
Phase I Report	10 JAN 95	20 JUN 95
Phase II	14 NOV 94	05 APR 95
Data Assessment Phase II	08 MAR 95	06 OCT 95
1154: RFI Report	10 JAN 95	09 SEP 96
1154: Voluntary Corrective Action Assessment	24 MAY 94	13 NOV 97

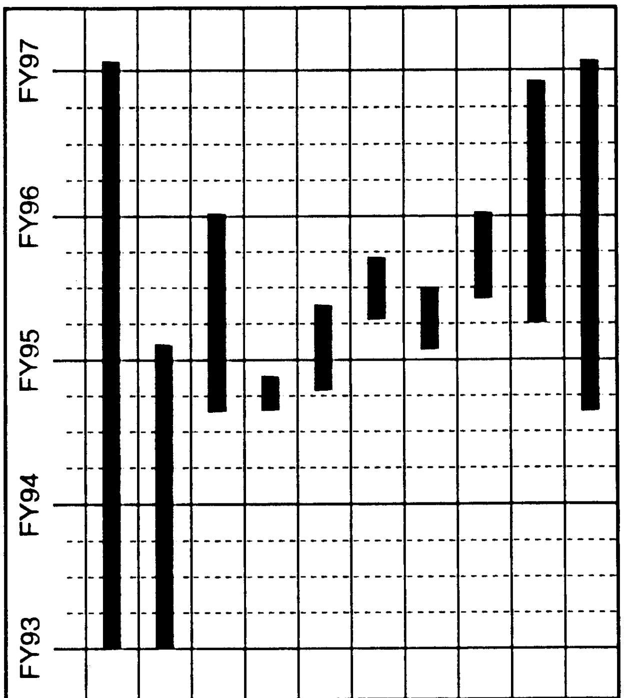

Figure ES-1. RFI milestone chart for OU 1154.

TABLE ES-1
Estimated Costs Of Baseline Activities at OU 1154

Task	Budget($K)	Scheduled Start	Scheduled Finish
RFI Work Plan	211	1 Oct 92	10 Nov 94
RFI	382	24 May 94	6 Oct 95
RFI Report	181	10 Jan 95	9 Sept 96
ADS Management	228	1 Oct 92	13 Nov 97
Voluntary Corrective Action	401	24 May 94	13 Nov 97
Total	1403		
Estimate to completion	1403		
Escalation	357		
Prior years	0		
Total at completion	1760		

- partial summaries of the results of initial site characterization activities;
- vehicles for proposing modifications to the sampling plans suggested by the initial findings;
- work plans that describe the next phase of sampling, when such sampling is required;
- vehicles for recommending VCA or NFA for PRSs shown by the RFI to have acceptable health-based risk levels; and
- summary reports of the sampling plans.

At the conclusion of the RFI, a final RFI report will be submitted to appropriate regulatory agencies or to the EPA.

Public Involvement

Public participation requirements apply to all environmental programs administered by the EPA and were established by Congress in consideration of the importance of citizen involvement. Requirements for public participation can be found in the Administrative Procedures Act (APA 5 USC Sections 551-559), which is applicable to all federal agencies, and in the EPA RCRA statutes, HSWA regulations, guidance documents, and facility permits that have expanded the opportunities for public participation beyond the requirements of the Administrative Procedures Act.

The Laboratory is providing a variety of opportunities for public involvement, including meetings held as needed to disseminate information, to discuss significant milestones, and to solicit informal public review of this draft work plan and other documents required under the RCRA corrective action process. The Laboratory also distributes meeting notices and updates the ER Program mailing list; prepares fact sheets summarizing completed and future activities; and provides public access to plans, reports, and other ER Program documents. These materials are available for public review between 9:00 a.m. and 4:00 p.m. on Laboratory business days at the Laboratory's public reading room at 1450 Central Avenue in Los Alamos and at the main branches of the public libraries in Española, Los Alamos, and Santa Fe.

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ACGIH	American Conference of Governmental Industrial Hygienists
ADS	Activity data sheet
ALARA	As low as reasonably achievable
AOC	Area of concern
BRET	Biological Resource Evaluation Team
CEARP	Comprehensive Environmental Assessment and Response Program
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
CMI	Corrective measures implementation
CMS	Corrective measures study
COC	Contaminant of concern
cpm	Counts per minute
DA	Deferred action
D&D	Decontamination and decommissioning
DOE	U.S. Department of Energy
DQO	Data quality objective
EES	Earth and Environmental Sciences (Division)
EO	Executive Order
EPA	U.S. Environmental Protection Agency
ER	Environmental Restoration
ES&H	Environment, safety, and health
FID	Flame ionization detector
FTL	Field Team Leaders
GC	Gas chromatograph
gpm	Gallons per minute
GET	General employee training
HAZWOP	Health and Safety Division Hazardous Waste Operations
H^2S	Hydrogen Sulfide
HDR	Hot Dry Rock (Geothermal Project)
HS	Health and Safety (Division)
HSPL	Health and Safety Project Leader
HSWA	Hazardous and Solid Waste Amendments

IWP	Installation Work Plan
JCI	Johnson Controls World Services, Inc.
kV	Kilovolts
LAAO	Los Alamos Area Office (of DOE)
LANL	Los Alamos National Laboratory
LASL	Los Alamos Scientific Laboratory (LANL before 1979)
LP	Laboratory Procedure
Ma	Million years ago
MAT	Materials Management Division
MSDS	Material Safety Data Sheets
NaID	Sodium iodide detector
NEPA	National Environmental Policy Act
NFA	No further action
NIOSH	National Institute for Occupational Safety and Health
NMDOG	New Mexico Division of Oil and Gas
NPDES	National Pollutant Discharge Elimination System
NMED	New Mexico Environment Department
OSHA	Occupational Safety and Health Administration
OU	Operable Unit
OUHSP	Operable Unit Health and Safety Plan
OUPL	Operable Unit Project Leader
OVA	Organic vapor analyzer
PC	Protective Clothing
PID	Photoionization detector
PL	Project Leader
PPE	Personal protective equipment
PQL	Practical quantitation limit
PRS	Potential release site
QA	Quality assurance
QAPjP	Quality Assurance Project Plan
QC	Quality control
QPP	Quality Program Plan
RCRA	Resource Conservation and Recovery Act
RFI	RCRA facility investigation

SAL	Screening Action Level
SAP	Sampling and analysis plan
SARA	Superfund Amendments and Reauthorization Act
SOP	Standard operating procedure
SOW	Statements of Work
SR	State Route
SSHSP	Site-specific health and safety plan
SSO	Site Safety Officer
SVOC	Semivolatile organic compound
SWMU	Solid waste management unit
TA	Technical Area
TAL	Target analyte list
TBD	To be determined
TSD	Treatment, storage, and disposal
TLV	Threshold limit value
TTL	Technical Team Leader
USGS	US Geologic Survey
VCA	Voluntary corrective action
VOC	Volatile organic compound
XRF	X-ray fluorescence

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- Installation Work Plan
- Description of OU 1154
- Organization of OU 1154 Work Plan

1.0 INTRODUCTION

1.1 Statutory and Regulatory Background

In 1976, Congress enacted the Resource Conservation and Recovery Act (RCRA), which governs the day-to-day operations of hazardous waste treatment, storage, and disposal (TSD) facilities. Sections 3004(u) and (v) of RCRA established a permitting system, which is implemented by the EPA or by a state authorized to implement the program, and set standards for all hazardous waste-producing operations at a TSD facility. Under this law, the Laboratory qualifies as a treatment and storage facility and must have a permit to operate. The State of New Mexico, which is authorized by the EPA to implement portions of the RCRA permitting program, issued the Laboratory's RCRA permit in November 1990.

In 1984, Congress amended RCRA by passing the Hazardous and Solid Waste Amendments (HSWA), which modified the permitting requirements of RCRA by, among other things, requiring corrective action for releases of hazardous wastes or constituents from SWMUs. The EPA administers the HSWA requirements in New Mexico at this time. In accordance with this statute, the Laboratory's permit to operate includes a section, HSWA Module VIII, that prescribes a specific corrective action program for the Laboratory (EPA 1990, 0306). The HSWA Module includes provisions for mitigating releases from facilities currently in operation and cleaning up inactive sites. This RCRA facility investigation work plan meets the requirements of the HSWA Module and is also consistent with the scope of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) in accordance with DOE policy (DOE 1989, 0078).

The Fenton Hill Site has been operating under a separate EPA identification (ID) number (ID NO. NMD986676807) from the Laboratory. The DOE submitted a notification of regulated waste activity and identified Fenton Hill as a small quantity generator to the New Mexico Environmental Department (NMED) in February 1992. Although Fenton Hill is not regulated under the Laboratory's RCRA permit, this work plan follows the RFI requirements of Module VIII of that permit to ensure that potential environmental problems influenced by Laboratory operations are investigated. It is intended to present a unified plan to the public and the regulators that addresses potential environmental problems under current Laboratory jurisdiction.

The HSWA Module lists SWMUs, which are defined as "any discernible unit at which solid wastes have been placed at any time, irrespective of whether the unit was intended for the management of solid or hazardous waste." These wastes may be either hazardous or nonhazardous (for example, construction debris). Table A of the HSWA Module identifies 605 SWMUs at the Laboratory, and Table B lists those SWMUs that must be investigated first. In addition, the Laboratory has identified areas of concern (AOCs), which do not meet the HSWA Module's definition of a SWMU. These sites may contain radioactive materials as well as hazardous substances not listed under RCRA. SWMUs and AOCs are collectively referred to as potential release sites (PRSs). The ER Program uses the mechanism of recommending no further action for AOCs as well as SWMUs. However, using this approach for AOCs does not imply that AOCs fall under the jurisdiction of the HSWA Module.

For the purpose of implementing the cleanup process, the Laboratory has aggregated PRSs that are geographically related in groupings called OUs. The Laboratory has established 24 OUs, and an RFI work plan has been or will be prepared for each. Three other RFI work plans submitted to EPA in 1994 and nineteen plans submitted between 1991 and 1993, meet the schedule requirements of the HSWA Module, which are to address a cumulative total of 100% of the SWMUs in Tables A and B of the HSWA Module by May 1994. Although none of the OU 1154 PRSs are listed in these tables and the site is not part of the HSWA Module itself, OU 1154 PRSs are addressed in this work plan and their investigations will follow HSWA criteria. These PRSs were originally documented in the November 1990 SWMU Report (LANL 1990, 0145).

As more information is obtained, the Laboratory proposes modifications in the HSWA Module for EPA approval. When applications to modify the permit are pending, the ER Program submits work plans consistent with current permit conditions. Program documents, including RFI reports and the Installation Work Plan (IWP), are updated and phase reports are prepared to reflect changing permit conditions.

1.2 Installation Work Plan

The HSWA Module requires that the Laboratory prepare a master plan, called the Installation Work Plan (IWP), to describe the Laboratory-wide system for accomplishing RFIs, VCAs and CMSs. The IWP has been prepared in accordance with the HSWA Module and is consistent with EPA's interim final RFI guidance (EPA 1989, 0088) and proposed Subpart S of 40 CFR 264 (EPA 1990, 0432), which proposes the cleanup program mandated in Section 3004(u) of RCRA. The IWP was first prepared in 1990 and is updated annually. This work plan generally follows the guidance in Revision 3 of the IWP (LANL 1993, 1017).

The IWP describes the aggregation of the Laboratory's PRSs into 24 OUs (Subsection 3.4.1). It presents the installation description in Chapter 2 and a description of the structure of the Laboratory's ER Program in Chapter 3. Chapter 4 describes the technical approach to corrective action at the Laboratory. Annexes I through V contain the Program Management Plan, Quality Program Plan, Health and Safety Program Plan, Records Management Program Plan, and the Public Involvement Program Plan, respectively. The document also contains a proposal to integrate RCRA closure and corrective action and a strategy for identifying and implementing interim remedial measures. When information relevant to this work plan has already been provided in the IWP, the reader is referred to the 1993 revision of the IWP.

1.3 Description of OU 1154

Operable Unit 1154 is a geothermal energy experimentation site, referred to as the Hot Dry Rock (HDR) project. This operable unit consists of TA-57, which is a fenced area referred to in this text as the "main compound" and three outlying areas. The first outlying area consists of well GT-1 in Barley Canyon, located about 2 miles north of the main compound. The second is a five-million-gallon pond located just outside the main compound, and the third is a sludge pit, located about 2 miles southwest of the main compound. Technical Area 57 is located 37 road miles almost due west of the Laboratory. Figure 1-1 shows TA-57 relative to the Laboratory while Figure 1-2 shows TA-57, the GT-1 well location and the site of the sludge pit.

The concept of HDR is to tap the geothermal energy that exists in the hot rock deep inside the Jemez Mountains by circulating water from one well, through the hot rock, and

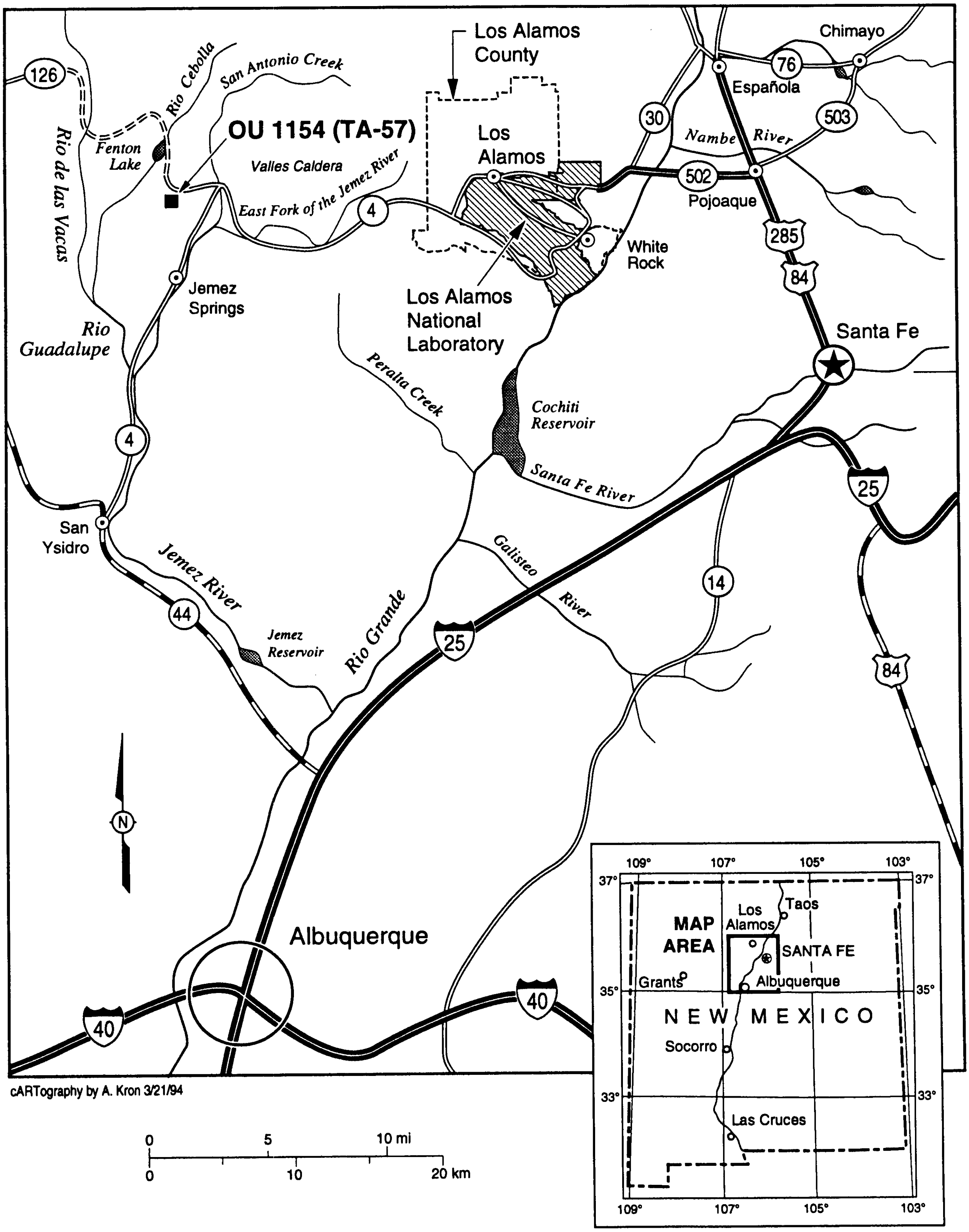


Figure 1-1. Location of TA-57 (Fenton Hill Site) in New Mexico.

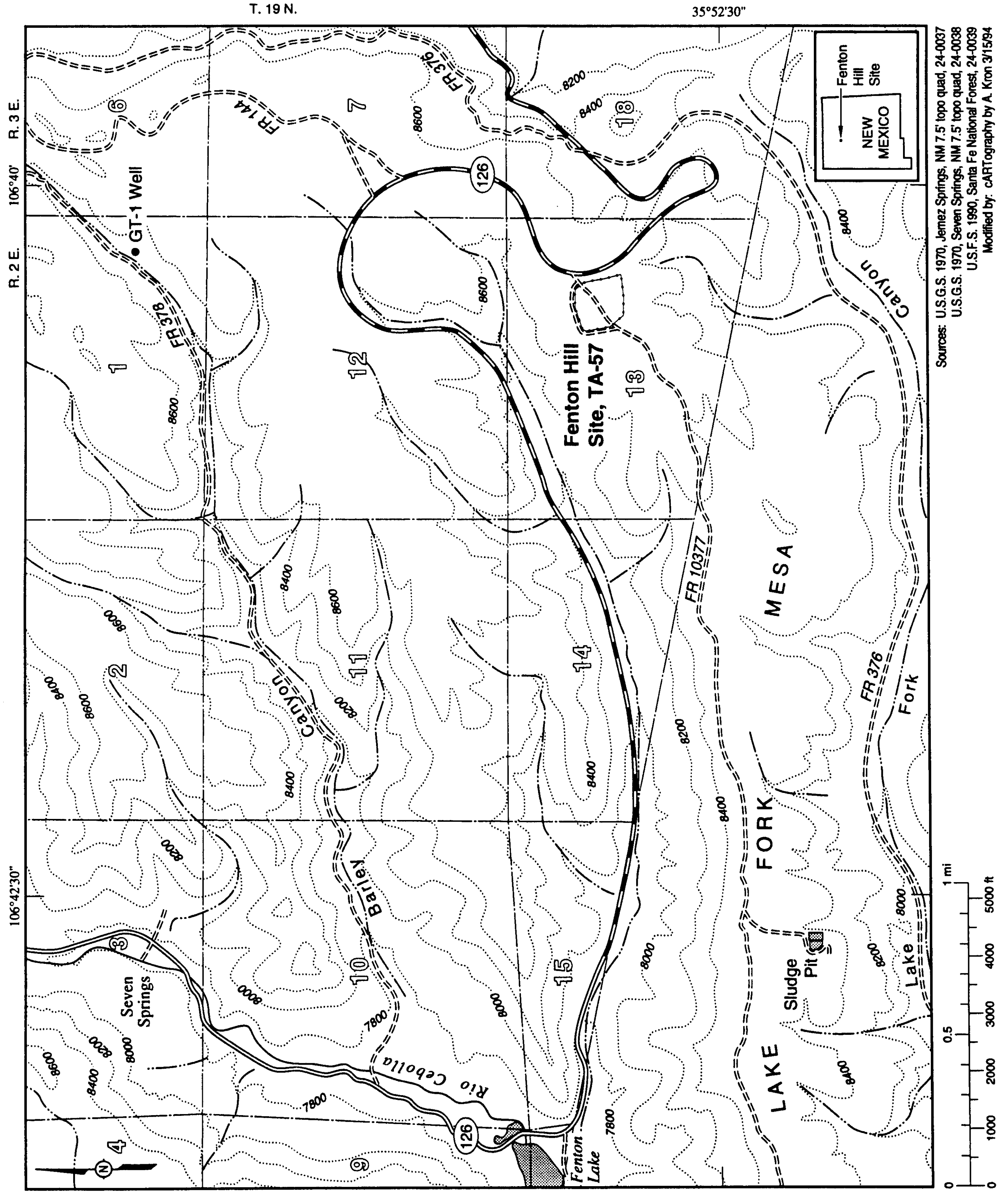


Figure 1-2. Location map of OU 1154 sites.

out through another well. The HDR concept has proved to be feasible and is used in many areas of the world, including Germany and Japan. The TA-57 site has been used only for research of the concept but was able to extract enough energy to supply a town the size of the nearby Jemez Springs, which has a population of about 500.

Operations began in 1972 with the drilling of well GT-1 in Barley Canyon and continued into the late 1980s with the drilling of several other wells at TA-57. Several wells extending to depths from a few hundred feet up to about 15,000 ft have been used to support the research operations. Table 1-1 lists the principal wells drilled in support of the operations at the Fenton Hill site and their approximate depths.

TABLE 1-1

List of Wells at Fenton Hill

WELL	DEPTH (FT)
GT-1	2,575
GT-2	10,000
EE-1	10,000
EE-2	15,000
EE-3	14,000

In addition to the wells, many other surface installations are support facilities for the operations. Currently existing are industrial-type facilities, including workshops and drum storage facilities; hydraulic installations, including pipeworks, pump houses, a heat exchanger, a small electric substation, and a small generating power plant; scientific facilities for monitoring the operations, including a passive seismological network and central data acquisition trailer; and support facilities for personnel, including meeting rooms, washrooms, offices, and a guard station. A chemistry trailer was also on site during the height of the research activities. This allowed for real-time analysis of the chemical makeup of the fluid as it was circulated through the wells. The fluid chemistry changed significantly as the water dissolved the minerals from the deep bore holes and as various additives were introduced to aid the circulation. The main compound is enclosed by a wire mesh fence that restricts entry. The site is currently active, although no research activities are occurring. The research activities are pending while funding to continue the activities is being sought.

For the purpose of evaluation, the PRSs within OU 1154 have been divided into five groups based primarily on their use and history. Figure 1-3 shows the locations of the structures on the site and the general locations of the PRS groups. Group 1 consists of the drilling mud pits that were constructed by the drilling crews as part of their operations. It is estimated that up to seven such pits may have been constructed, then backfilled on completion of each drilling operation; however, documentation confirms only two pits. Group 2 consists of a system of settling ponds that were constructed as part of the geothermal fluid circulation system. There were two settling ponds, an experimental pond, a pond filtration system that filtered the water from one of the settling ponds prior to release, and a fourth reserve pond. The outfall from the settling ponds released water to a dry tributary that was named Burns Swale for the investigation purposes of this work plan. The sediments in this swale are also investigated as part of Group 2. A sludge disposal pit is investigated individually under Group 3. The sludge originates from the settling ponds on site. Group 4 consists of a chemical waste storage drum that was used to receive sink drainage from the chemistry laboratory and a leach field also used by the laboratory. Group 5 consists of a waste container storage facility, which includes both fuel storage and satellite waste storage areas. Table 1-2 is a list of all the PRSs in OU 1154 and the proposed action for each. This table includes the PRSs within OU 1154 proposed for no further action. These are sites that have been determined, after extensive investigation, not to require further action on the part of the ER Program because there has been no release of hazardous constituents to the environment or the PRS never managed hazardous constituents. As more information is obtained, the Laboratory proposes modifications to the HSWA Module for EPA approval of the no further action determination. Although these sites will not affect the HSWA Module, the same standards will be followed.

1.4 Organization of the OU 1154 Work Plan

This work plan generally follows the generic outline provided in Table 3-3 of the IWP (LANL 1993, 1017). Following this introductory chapter, Chapter 2 provides background information on OU 1154, including a description and history of the OU, a description of past waste management practices, and current conditions in the OU. Chapter 3

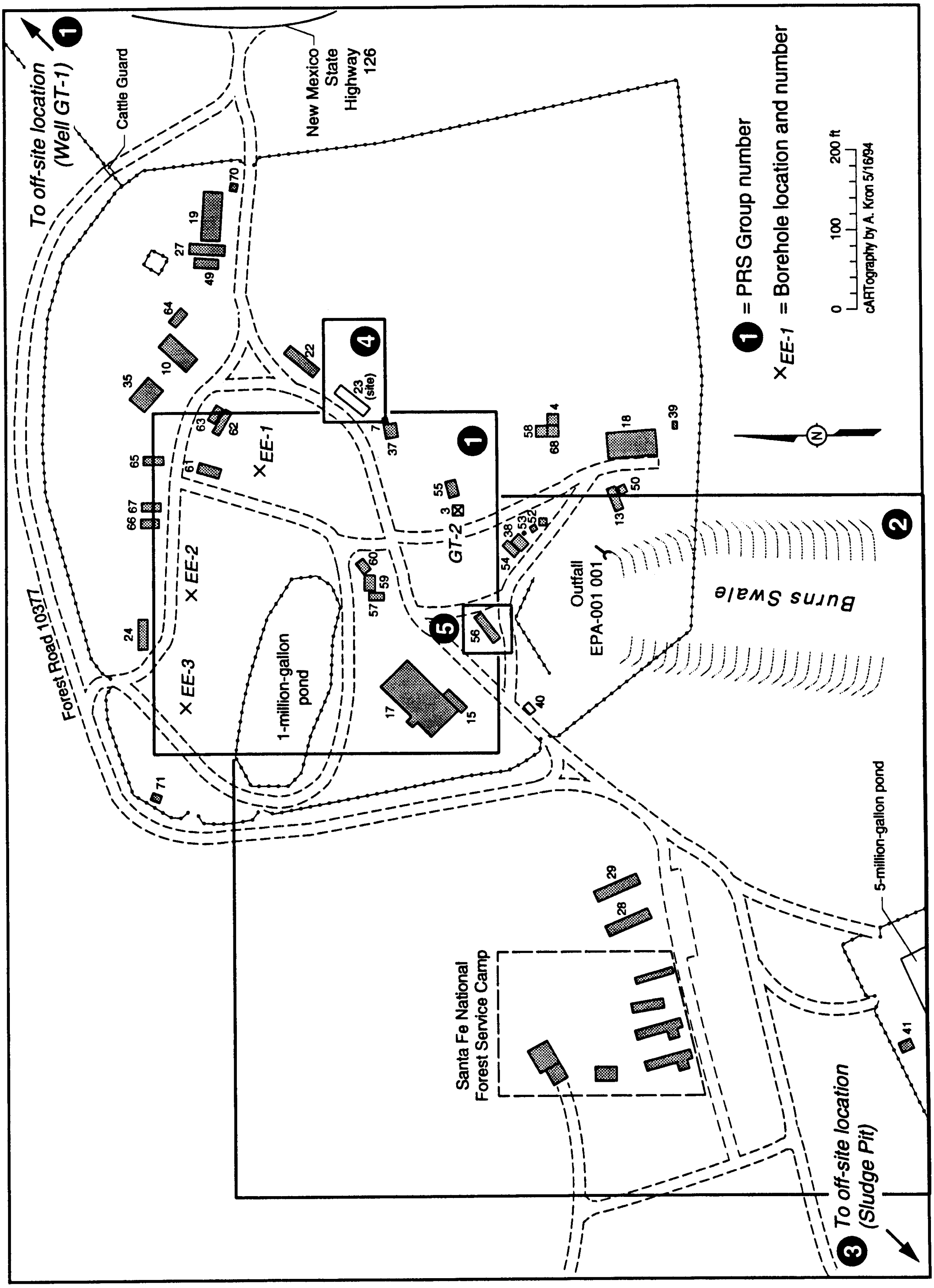


Figure 1-3. Locations of structures and PRS groups at TA-57.

TABLE 1-2

Proposed Actions for Potential Release Sites in OU 1154

Group	PRS Number	Unit Type	NFA	VCA	Phase 1	Deferred
1	57-001(a)	Drill Pit	X			
2	57-001(b)	Settling Pond			X	
2	57-001(c)	Experimental Pond			X	
2	57-004(a)	Settling Pond			X	
2	57-004(b)	Storage Pond				X
2	57-005	Filtration Unit	X			
3	57-002	Sludge Pit			X	
4	57-006	Chemical Waste Drum		X		
4	57-007	Chemical Waste Leach Field			X	
5	57-003	Container Storage Area				X

describes the environmental setting, and Chapter 4 presents the technical approach to the field investigation. Because the technical approach is specific to this work plan, the details in Chapter 4 are slightly different than those proposed in the generic IWP outline. Chapter 5 contains an evaluation of the PRSs in OU 1154, including a description and history of each PRS; a conceptual exposure model; remediation alternatives and evaluation criteria; data needs and data quality objectives; and the sampling plans for each PRS proposed for Phase I sampling. Chapter 6 of this work plan provides a description of each PRS proposed for no further action and the basis for that recommendation.

The body of the text is followed by five annexes, which consist of project plans corresponding to the program plans in the IWP: project management, quality assurance, health and safety, records management, and public involvement. Appendix A contains a list of contributors to this work plan.

Both English and metric units are used in this document, depending upon which unit of measurement is commonly used in the field being discussed. For example, English units are used in text pertaining to engineering, and metric units are often used in discussions referring to sampling techniques and analysis, geology, and hydrology. When information is derived from other published reports, the units are consistent with those used in that report. Metric to English conversions are provided in Table 1-3 for convenience.

A list of acronyms precedes Chapter 1. Definitions of unfamiliar terms specific to this work plan can be found in the glossary. A glossary of generic unfamiliar terms is provided in the IWP (LANL 1993, 1017).

TABLE 1-3

Approximate Conversion Factors for Selected SI (Metric) Units

Multiply SI (Metric) Unit	by	To Obtain US Customary Unit
Cubic meters (m^3)	35	Cubic feet (ft^3)
Centimeters (cm)	0.39	Inches (in.)
Meters (m)	3.3	Feet (ft)
Kilometers (km)	0.62	Miles (mi)
Square kilometers (km^2)	0.39	Square miles (mi^2)
Hectares (ha)	2.5	Acres
Liters (L)	0.26	Gallons (gal.)
Grams (g)	0.035	Ounces (oz)
Kilograms (kg)	2.2	Pounds (lb)
Micrograms per gram (ug/g)	1	Parts per million (ppm)
Milligrams per liter (mg/L)	1	Parts per million (ppm)
Celsius (°C)	9/5 + 32	Fahrenheit (°F)

References

DOE (US Department of Energy), October 6, 1989. "Comprehensive Environmental Response, Compensation, and Liability Act Requirements," DOE Order 5400.4, Washington, DC. (DOE 1989, 0078).

EPA (US Environmental Protection Agency), May 1989. "Interim Final RCRA Facility Investigation (RFI) Guidance, Volume I of IV, Development of an RFI Work Plan and General Considerations for RCRA Facility Investigations," EPA/530-SW-89-031, OSWER Directive 9502.00-6D, Office of Solid Waste, Washington, DC. (EPA 1989, 0088).

EPA (US Environmental Protection Agency), April 10, 1990. RCRA Permit No. NM0890010515, EPA Region VI, issued to Los Alamos National Laboratory, Los Alamos, New Mexico, effective May 23, 1990, EPA Region VI, Hazardous Waste Management Division, Dallas, Texas. (EPA 1990, 0306).

EPA (US Environmental Protection Agency), July 27, 1990. "Corrective Action for Solid Waste Management Units (SWMUs) at Hazardous Waste Management Facilities," proposed rule, Title 40 Parts 2364, 265, 270, and 271, Federal Register, vol. 55, pp 30798-30884. (EPA 1990, 0432).

LANL (Los Alamos National Laboratory), November 1993. "Installation Work Plan for Environmental Restoration", Revision 3, Los Alamos National Laboratory Report LA-UR-93-3987 Los Alamos, New Mexico. (LANL 1993, 1017).

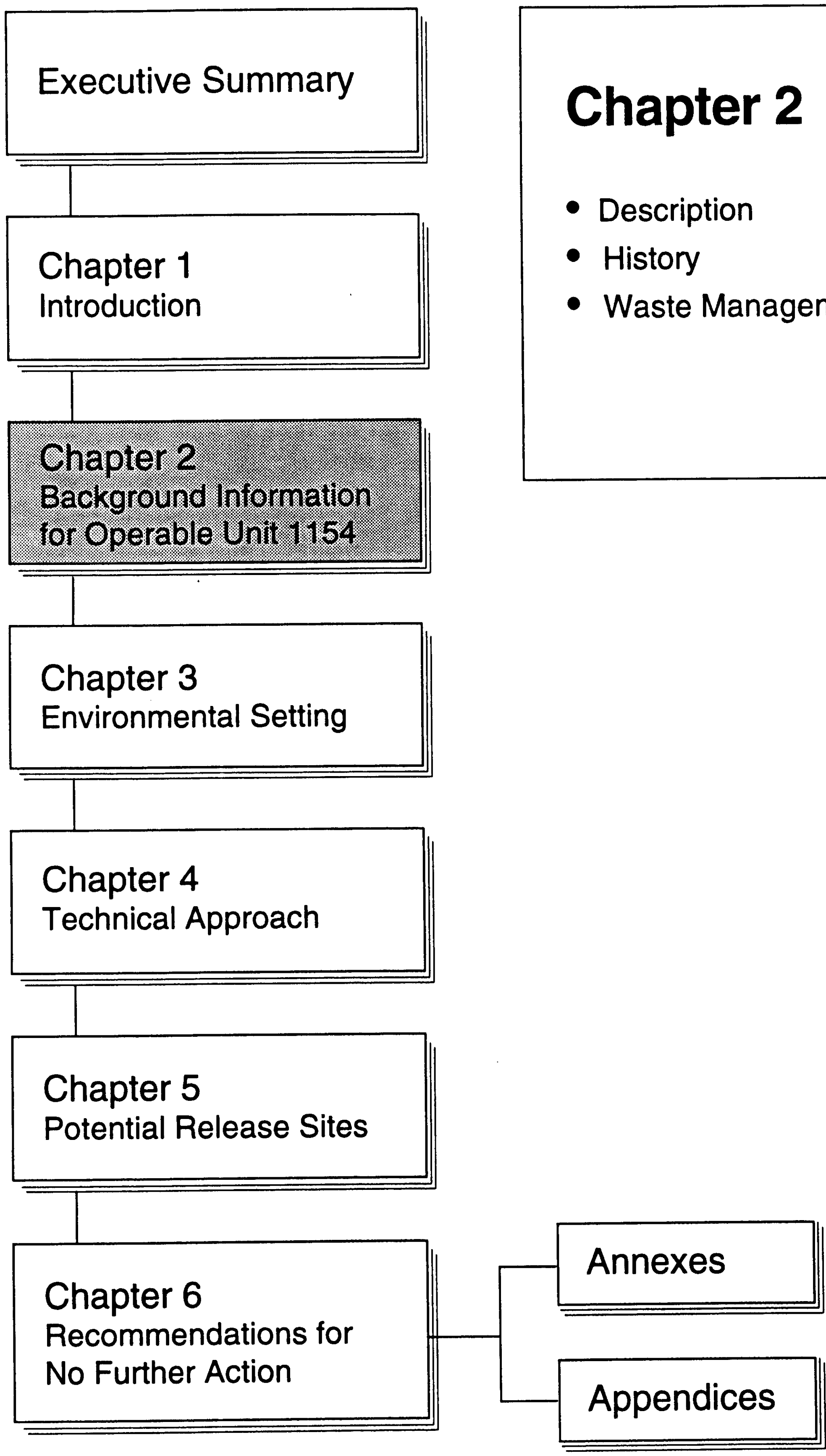
LANL (Los Alamos National Laboratory), November 1990. "Solid Waste Management Units Report," Volumes I through IV, Los Alamos National Laboratory Report LA-UR-90-3400, prepared by International Technology Corporation under Contract 9-XS8-0062R-1, Los Alamos, New Mexico. (LANL 1990, 0145).

USGS (U.S. Geological Survey) 1970. "Seven Springs, New Mexico," Map No. N3545-W10630/15 (top half), Map No. 35106-G6-TF-024, Denver, Colorado. (USGS 1970, 24-0038)

USGS (U.S. Geological Survey) 1978. "Los Alamos, New Mexico," Map No. N3530-W10600/30x60, Denver, Colorado. (USGS 1978, 24-0086)

USGS (U.S. Geological Survey) 1952. "Jemez Springs, New Mexico," Map No. N 355 2.5-W10637.5/7.5, Denver, Colorado. (USGS 1952, 24-0037)

USFS (U.S. Forest Service)1990. "Santa Fe National Forest, New Mexico," Albuquerque, New Mexico.(USFS 1990, 24-0039)



Chapter 2

- Description
- History
- Waste Management Practices

2.0 BACKGROUND INFORMATION FOR OPERABLE UNIT 1154

2.1 Description

2.1.1 Geographic Setting

Technical Area 57 is located on Fenton Hill, which lies on the western side of the Jemez Mountains, at an elevation of approximately 8,700 feet. This location is 37 road miles west of the main site of Los Alamos National Laboratory in Los Alamos, New Mexico. The route from the main Laboratory site to Fenton Hill is by winding mountain roads that cross the Jemez Mountains. Consequently, environmental factors at TA-57 may be different from those at the main Laboratory area. The Jemez Mountains are dominated by a circular caldera, with several lava domes within the caldera. On the west side of the mountains, a rim valley is occupied by San Antonio Creek, on which the township of La Cueva is located, about 3 to 4 road miles east of TA-57.

Outside the rim a high-elevation plateau circles the caldera. The main Laboratory site lies on the eastern side of the caldera, known as the Pajarito Plateau, whereas TA-57 is on the western side, known as the Jemez Plateau. On the western side of the mountains, the plateau is interrupted by radial streams flowing westward in deep canyons. These canyons and mesas encountered from south to north near TA-57 include Cañon de San Diego (which incorporates the Jemez River), Virgin Mesa, Virgin Canyon, Cebollita Mesa, Lake Fork Canyon, Lake Fork Mesa, an unnamed canyon, an unnamed mesa, and Barley Canyon. The geothermal operations at Fenton Hill occurred in the transition zone between the caldera rim and Lake Fork Mesa, and in Barley Canyon to the north.

The name Fenton Hill does not appear on U.S. Geologic Survey (USGS) maps. It is an informal designation originally given to the trail that leads out of the rim valley onto the caldera rim and Lake Fork Mesa along the road from La Cueva to Fenton Lake. However, common usage now assigns the name to this area of Laboratory operations.

The drainage from the main Laboratory site is eastward toward the Rio Grande, whereas the drainage from Fenton Hill is westward toward the Jemez River. The recreational area of Fenton Lake and the communities of Gilman and Cañones are potentially the first human occupations that would be affected by discharges from Fenton Hill. The drainage from Fenton Hill joins the Jemez River near Jemez Pueblo. The Jemez River eventually joins the Rio Grande at Angostura about 12 miles north of Albuquerque. Figure 2-1 shows the geographic setting of the Fenton Hill site.

2.1.2 Mission of Fenton Hill

The Fenton Hill site was selected to test the feasibility of extracting heat from hot rocks deep in the earth. Because heat flow from magma bodies that lie at the interior of the Jemez Mountains has made the surrounding rocks abnormally hot, a site near the rim of the Valles caldera was chosen to test the concept of geothermal energy extraction. A site in Barley Canyon was first selected because it is a region of high-temperature gradient and less drilling was required to reach hotter rocks. However, the Barley Canyon site was abandoned after one drill hole (GT-1), primarily because of poor winter access and the topographic restrictions on the site area. The Fenton Hill site offered a large flat area that was easier to reach in winter, where the forest had recently been destroyed by a fire, the facilities would be more useful to the U.S. Forest Service following project completion, and where the heat flow characteristics were nearly the same. Given these advantages, the operations were shifted to the present site of TA-57, commencing with drilling of GT-2 (Kaufman and Siciliano 1979, 24-0013).

2.1.3 Method of Operation

The operations took place in an alternating succession of two modes. In the drilling mode, a drill rig was located on site, and operations that required the rig, including drilling, workover operations, logging, and massive hydraulic fracturing, were conducted. In the circulating mode, fluid was pumped down an injection well. The fluid then flowed through induced fractures in the rock to a production well, where it was pumped back to the surface. At the surface, the emergent water was returned to the injection well through a surface loop that included heat exchangers to extract its heat. Additional details of the operations are presented in Section 5.2.

2.1.4 Land Use Agreements

Fenton Hill, unlike the main Laboratory site, is not owned by the Department of Energy (DOE). It is leased by the DOE from the U.S. Forest Service. Activities at Fenton Hill have been conducted at three main locations: TA-57, Barley Canyon, and a sludge pit\

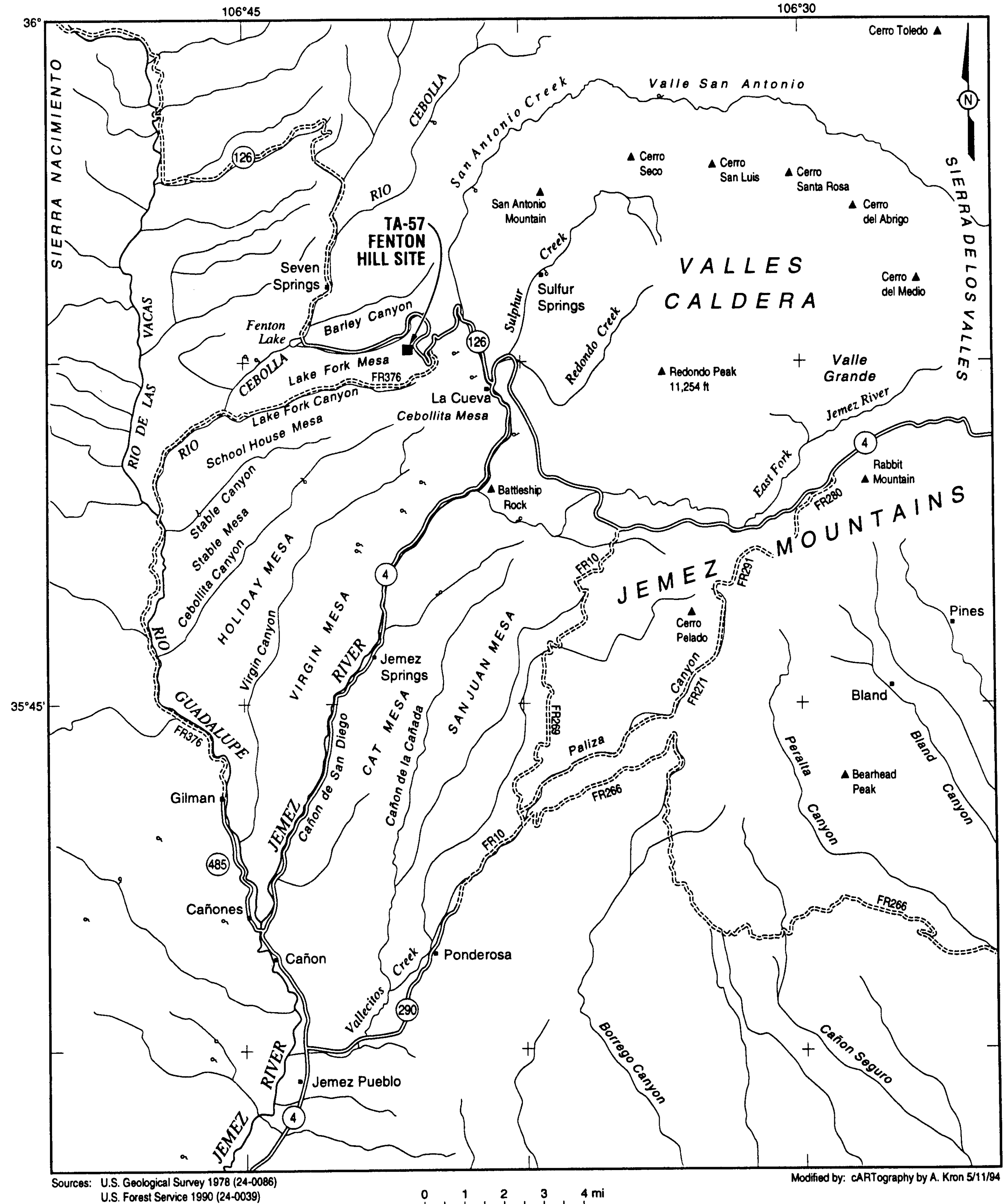


Figure 2-1. Geographic setting of TA-57 (Fenton Hill Site).

that was formerly a gravel pit on Lake Fork Mesa (Fig. 1-2). These sites are within Santa Fe National Forest boundaries, and operations there are conducted pursuant to an agreement with the U.S. Forest Service. Disposal of the drilling wastes generated as a result of the Fenton Hill activities were conducted at the sludge pit to the west by arrangement with the U.S. Forest Service. There was also a widespread network of seismic recording stations and miles of electrical cable in shallow trenches joining the stations to TA-57.

Applicable memoranda of operations have been reviewed for impact to the RFI and are listed in the references (DOE 1973, 24-0003; LANL 1987, 24-0004; LANL 1985, 24-0007; DOE 1972, 24-0008; DOE 1973, 24-0080; DOE 1979, 24-0079; LANL 1984, 24-0009). These concern the exploratory drilling and construction of the seismic monitoring net, the Barley Canyon drill site, the 20 acres at the TA-57 site, the drilling of heat flow holes A, B, C, and D, and the approximately 30 telemetry stations and six seismic stations. In addition, the DOE was allowed to conduct geological and geophysical sampling and drilling, and to set up and operate environmental monitoring stations. At a later date, there was agreement to permit construction of the five-million-gallon pond just outside the TA-57 compound.

The site at TA-57 and the five-million gallon pond are enclosed by a perimeter wire fence, with controlled access by the Laboratory. Access is not restricted at buildings owned by the U.S. Forest Service on an adjoining site. Electrical, water, and sewage services are connected between the site and the U.S. Forest Service facilities.

2.1.5 Permitting

The operations at Fenton Hill took place in an environment of increasing regulation. Accordingly, the permit requirements changed during operations. Figure 2-2 illustrates in a qualitative fashion the change in the regulatory environment and the dates when wells GT-1, GT-2, EE-1, EE-2, and EE-3 were constructed at Fenton Hill.

The first group of applicable requirements was determined by agreement between the Laboratory and the U.S. Forest Service. These concerned pumping of sanitary effluent from TA-57 to the U.S. Forest Service sewage drainfield and placing the pond sludge from TA-57 in a gravel pit within the Santa Fe National Forest, about 2 miles southwest of TA-57 (DOE 1987, 24-0002; LANL 1984, 24-0009).

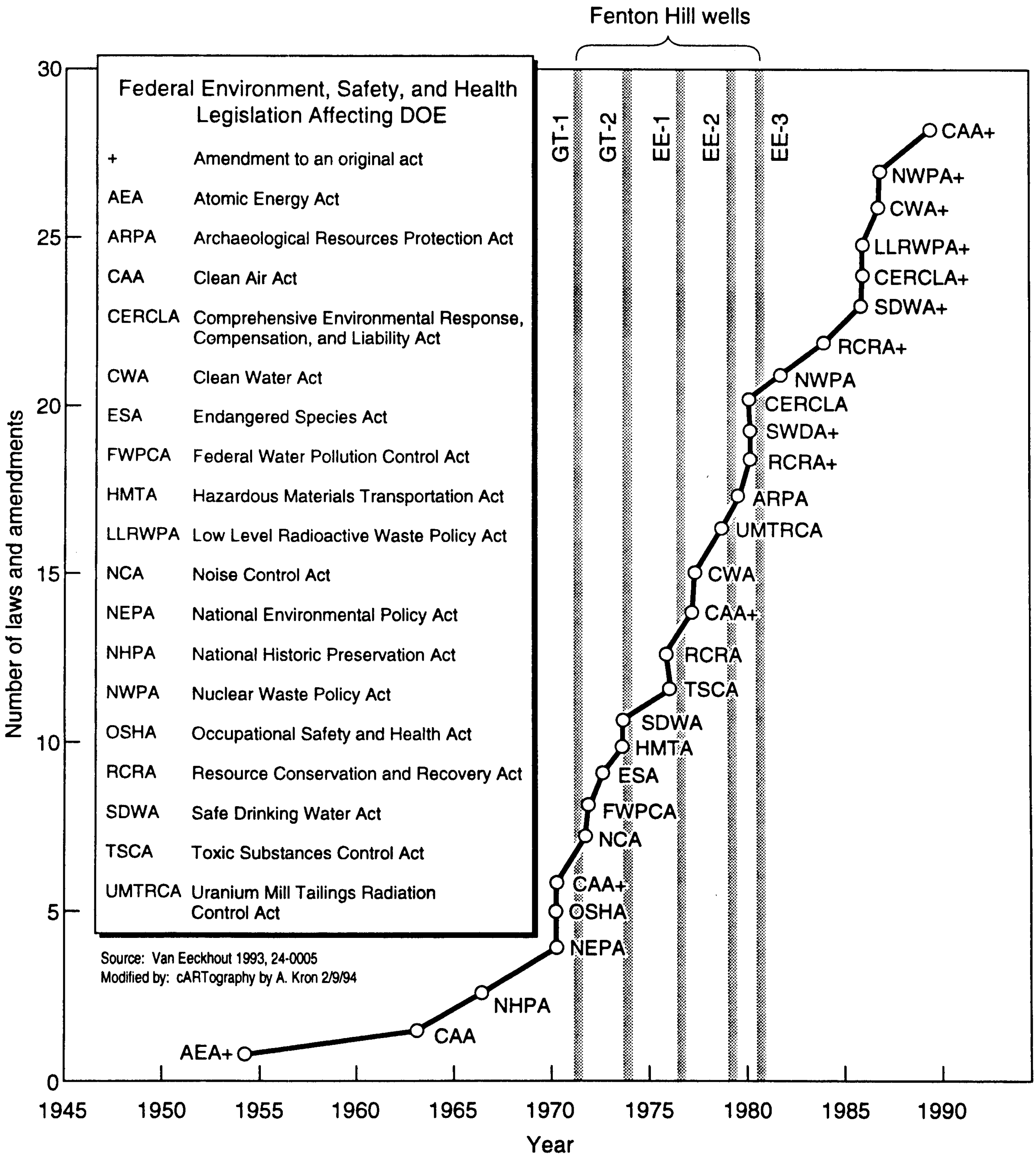


Figure 2-2. Changes in regulatory environment during Fenton Hill operations.

The second group of regulations was by agreement between the U.S. Forest Service, acting as landlord, and what is currently the New Mexico Environment Department, (NMED) acting on behalf of the EPA's Region 6. An environmental analysis report issued in 1979 provided for operation of an NPDES wastewater discharge outfall at TA-57, which released excess circulation water into Lake Fork Canyon by way of Burns Swale, a dry tributary to Lake Fork Canyon. Burns Swale is an unofficial name given to this tributary for purposes of this work plan. (LANL 1985, 24-0007). This outfall was numbered EPA 001 001 and is shown on Figure 1-3.

The third group of regulations governed drilling operations, including discharge of noxious gases such as H_2S, and was administered by the State of New Mexico Division of Oil and Gas (LANL 1987, 24-0004). The operation and restoration of the drilling mud pits was conducted according to these regulations.

2.2 History

The history of major activities of the HDR is summarized in Table 2-1. (Burns and Hendron 1993, 24-0006). Specific facility descriptions are presented in Chapter 5. A schematic drawing of a geothermal energy circulation loop is shown in Figure 2-3.

2.3 Waste Management Practices

2.3.1 Generation of waste

The operations at Fenton Hill generated considerable quantities of waste and liquid effluent. The types of waste generated depended upon the mode of operation. During drilling, various materials were trucked onto the site, placed in bulk storage facilities on or near the rig, and then fed into the drill hole. The material circulated through the well, then was filtered at the surface in filter units and settling ponds. The filtered water was returned downhole. Particulate matter was recovered as solid waste from the filtration system. There was thus a drilling loop, with circulating drilling muds and output gravel or particulate material. After the drilling operation, the hole was cleaned of circulating mud, and the mud settled out of the water in the on-site settling ponds. When the pond water was sufficiently clear to meet NPDES limits for particulates, it was discharged to the EPA outfall. The pond bottom sludge was removed and disposed of in the sludge pit. At the

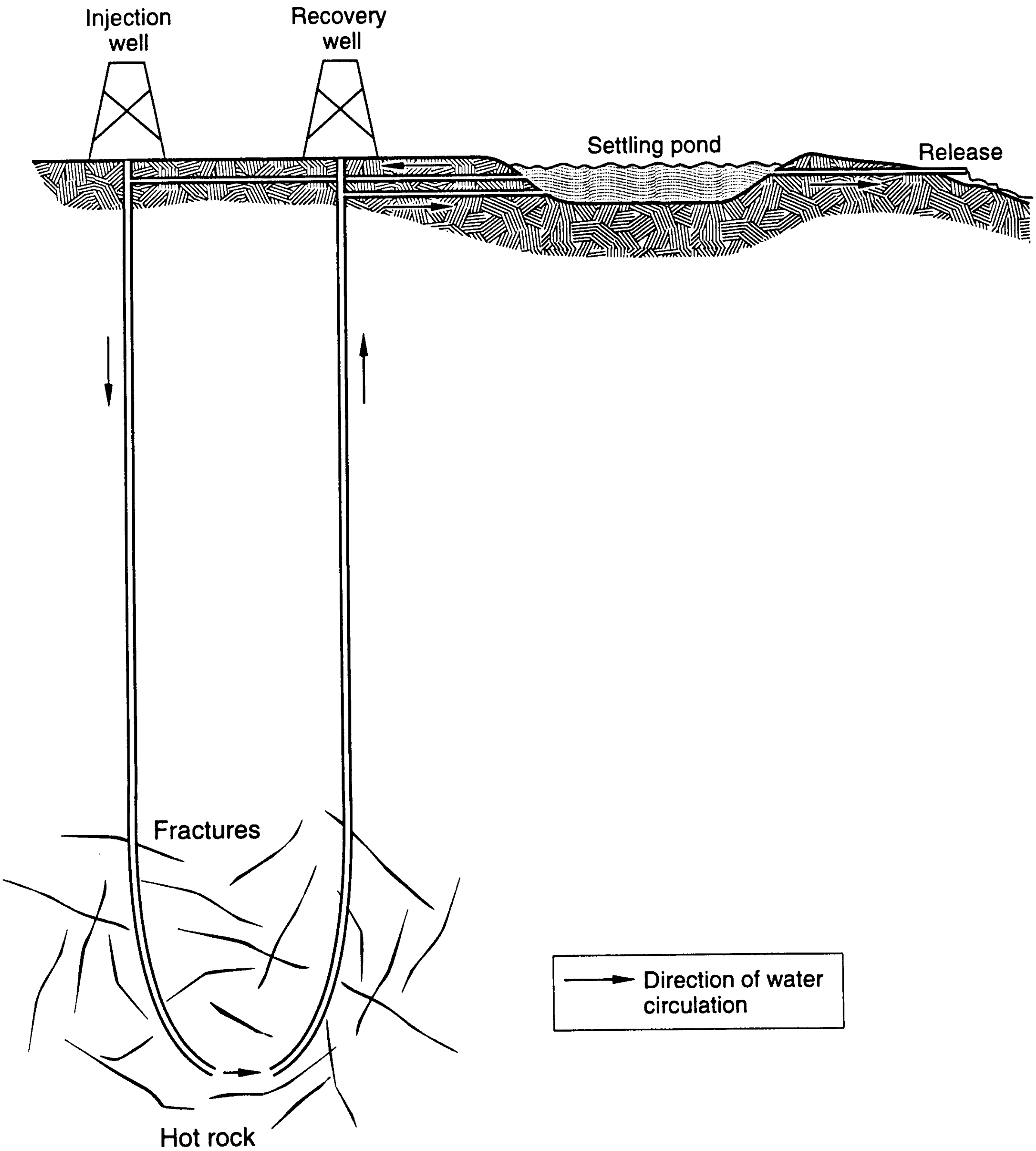


Figure 2-3. Schematic drawing of geothermal energy recovery circulation loop.

TABLE 2-1

History of HDR

Fiscal Year	Activities
1970	• Hydraulic fracturing HDR concept developed. • Unofficial LASL HDR Program initiated.
1971	• Feasibility and cost studies (drilling, hydraulic fracturing, heat disposal).
1972	• Investigated Valles caldera and western Los Alamos County as possible experimental sites. • Drilled and logged 10 shallow (approximately 100 ft), 4 intermediate-depth (approximately 600 ft), and one deep (2575 ft) exploratory hole, GT-1. • First report on HDR submitted to AEC. • First public presentation and published report on HDR. • Initial involvement of USGS.
1973	• Logging and permeability tests in well GT-1. • Aerial survey conducted of area west of Valles caldera. • Preliminary HDR resource assessment of the U.S. • Petrography of core samples, studies of faults and earthquakes, by visiting staff members. • Hydrology and seismometry studies. • Planning for second exploratory hole initiated. Possible location at Fenton Hill mapped.
1974	• Permeability measurements, hydraulic-fracturing experiments, and stress measurements in GT-1. • Continuing study and monitoring of hydrology and water quality begins in area west of Valles caldera, including GT-1 area and Fenton Hill. • Intensive development of high-temperature downhole instruments begins. • Preparation of site at Fenton Hill for drilling of second exploratory hole, well GT-2. • Began drilling well GT-2.

1975

- Completed well GT-2.
- Logging, hydraulic fracturing, and pressurization tests in GT-2.
- Drilling begins on well EE-1 at Fenton Hill, the first well of an experimental two-hole heat-extraction system.

1976

- Decision to complete first underground loop between GT-2 and EE-1 instead of drilling another well at Fenton Hill.
- Completed well EE-1. Did not intersect hydraulic fractures generated from GT-2.
- Fractured hydraulically from EE-1. Produced high-impedance connection to GT-2.

1977

- Redrilled lower part of GT-2. Flow impedance much reduced but still excessive.
- Redrilled GT-2. Impedance now satisfactory.
- Surface facility constructed to complete "Phase I" system—a closed, recirculating, pressurized-water, heat-extraction loop.

1978

- Successful 75-day flow-test of Phase I system.
- Began high-back-pressure flow test of Phase I system.
- Continuing development of high-temperature drilling equipment and downhole instrumentation, much of it in cooperation or by contact with industry and universities.

1979

- Completed 38-day flow test against high back-pressure, which reduced flow impedance. Shut down prematurely by deterioration of cement around casing in injection well (EE-1).
- Recemented EE-1 casing.
- Phase I fracture system enlarged by additional hydraulic fracturing.
- Continued development and application of high-temperature logging and diagnostic instruments and techniques, including successful microseismic mapping of Phase I fracture system.
- Studies of drill cores from well EE-1.
- Extensive evaluation of HDR resource base of the US, with field investigations in 30 states by LASL and, under contract, industrial and university groups.
- Search for a second experimental site intensified.
- Environmental Analysis Report for Fenton Hill issued.
- Detailed planning for a deeper, hotter, Phase II system at Fenton Hill.
- Drilling begins on well EE-2, the injection well of the Phase II system.

1980

- Well EE-2 completed.
- Phase I system operated for 28 days to evaluate enlarged reservoir.
- Resource evaluation and site-characterization continued
- Drilling begins on well EE-3,
- Extended flow test of the Phase I system begins ("Run Segment 5").

1981

- Phase I, Run Segment 5, completed successfully; duration 9 months.
- Drilling of well EE-3 continued until hole junked by twisted-off bottom-hole drilling assembly.
- Well EE-3 sidetracked and redrilled successfully.
- Design of Phase II surface system initiated.

1982

- Well EE-2 cleaned.
- Repeated hydraulic fracturing in EE-2 produced no connection to EE-3.
- Five-million-gallon water-storage pond constructed.

1983

- Large hydraulic-fracturing operation in EE-2. No connection to EE-3.
- Fracturing operations in EE-3. No connection to EE-2.
- Initiated explosive-tool development.
- Intensive geochemistry studies.
- Initiated expansion and installation of the first lining of Pond GTP-1.

1984

- Massive hydraulic-fracturing operation in EE-2. No connection made to EE-3. Terminated by equipment failure resulting in rapid uncontrolled vent and damage to EE-2 casing and fracturing string.
- Large hydraulic-fracturing operation in EE-3. No connection to EE-2.
- Initiated development of chemically reactive tracers for use in mapping temperature in a fractured geothermal reservoir.
- Completed lining of Pond GTP-1.

1985

- Well EE-2 repaired.
- Well EE-3 sidetracked and redrilled. Good connection made to EE-2.
- Short series of flow tests to investigate connection between wells.
- Successful 84-hour flow test of Phase II system.
- Studies of EE-2 and EE-3 cores, fluid flow in deformable joints, fracture apertures, degradation of sepiolite drilling muds, calcite deposition, corrosion of cable armor and surface components, additional chemically reactive tracers and their adsorption, low-frequency long-period microseismic events, modeling of observed thermal effects.

1986

- Completed redrilled well EE-3 with downhole hardware designed for long-term flow testing.
- Conducted 30-day "Initial Closed-Loop Flow Test" of completed Phase II system Test included seismic monitoring, temperature logging, monitoring the chemistry of the recirculated fluid, tracer experiments, use of corrosion inhibitors, modeling studies, etc.

1987

- Determined that obstruction at 10,500-ft depth in EE-2 was partially collapsed casing and liner. Attempt to repair it by milling operations unsuccessful. Reservoir Damage Evaluation Panel recommended sidetracking and redrilling around the obstruction. This was undertaken late in FY87.
- Detailed planning for a 1- to 2-year flow test of Phase II system.

1988

- Completed redrilling and completion of well EE-2. Full-length casing and liner installed.
- Developed improved cementing techniques.
- Increased sensitivity of chemical analyses for reactive tracers and their reaction products.

1989

- Filled and pressurized Phase II and initiated long-term study of steady-state water-loss rates at a series of elevated system pressures.
- Continued development of chemically reactive tracers and extremely sensitive analytical procedures for them.

1990

- Continued materials and component selection, procurement, and installation in the Phase II surface system.
- Water-loss study of the Phase II fractured reservoir continued. Determined that water-loss rate decreased with time for about one year, representing 2-dimensional diffusion, but then decreased more slowly implying a change to spherical diffusion. Water-loss rates soon became very low, and system continued to generate seismic activity to highest injection pressure used (3600 psi). Ultrasonic inspection of existing key surface components showed no significant corrosion from previous use. Physical inspection of the interiors of heat-exchanger tubes showed a variety of scale deposits but no evidence of severe pitting or excessive loss of wall thickness. All used components remaining in surface system appeared satisfactory for the long-term flow test.
- One-million gallon water-storage pond cleaned, contoured, and relined.

1991

- Continued water-loss studies. Analysis of pressure-increase data indicates that up to reservoir pressures of about 15 MPa, 73% of water storage is in microcracks in the body of the reservoir and only 27% in joints and fractures. The reservoir appears to saturate at 15 MPa and at higher pressures additional storage is apparently only in expanded joints and fractures.

1992-Present

- Operations limited pending funding.

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pit, the water in the sludge either drained away into rock underlying the unlined disposal pit or evaporated.

A second type of waste was generated during circulation tests. Water was pumped down one well, flowed through the rock, where it dissolved naturally occurring metals and other inorganics from the rock, and was brought back to the surface in a second well, bringing the materials with it. Ponds were used as storage components in the circulating loops. When water that was resident in the ponds cooled, metals were precipitated or absorbed onto bottom muds. Gradual accumulation of metals occurred in both the water and in the muds. Excess water was discharged to surface drainage as effluent, while pond bottom sediments were taken to the sludge pit.

Liquid waste discharges were governed by NPDES Permit No. NM0028576 (LANL 1985, 24-0007). Solid waste disposal was governed by agreement between the DOE and the

U.S. Forest Service (DOE 1987, 24-0002). Sanitary waste discharges were pumped to the U.S. Forest Service drainfield (LANL 1984, 24-0009). Reagent chemicals were discharged to a buried drum under the chemistry trailer. When the drum reached capacity, the liquid was pumped out and transported to the main Laboratory for disposal. The leach field near the chemistry trailer also received diluted chemicals from operations within the trailer. The site also has a satellite waste storage area operating in accordance with the Laboratory's generator requirements.

2.3.2 Chemical constituents of waste

Chemical constituents associated with OU 1154 were derived primarily from the drilling and subsequent testing activities. Most chemicals introduced during drilling were associated with muds and other fluids used to lubricate and prop the holes. The larger quantity additives included bentonite clay, barium sulfate, sodium hydroxide, ammonium bisulfite, cotton seed hulls, lime, sawdust, and walnut hulls. Smaller quantity additives included organic compounds such as para-formaldehyde used in small quantities as a biocide, organic solvents and salts, organic and inorganic acids, isopropyl alcohol, and phosphate descaler. Most of the additives had no hazardous components.

During hydrothermal testing, the circulating fluids dissolved and mobilized residual additives that remained in the wells as well as new species from the reservoir rock. The new species included a variety of metals and other inorganics, such as boron, arsenic, lithium, cadmium, sodium, uranium, fluoride, sulfate, chloride, silica, and carbonates. Although the solid particles were removed from the circulating water in settling ponds and filtration systems, the concentrations of the dissolved constituents increased over time, limiting the extent to which the water could be reused.

Chemical and radioactive tracers were introduced into the circulating water during the tests to map temperatures and help determine reservoir characteristics. The chemical tracers consisted of such compounds as sodium fluorescein, sodium bromide, sodium nitrate, and p-toluenesulphonic acid (p-TSA). For radioactive tracers, ^{82}Br was most commonly used but ^{131}I was also used in the earlier studies. The maximum quantity reported to have been used in any tracer test was 250 pounds of sodium bromide, while tests involving p-TSA used less than 200 g of tracer (Dennis et al. 1980, 24-0081; Robinson 1986, 24-0082; Robinson et al. 1987, 24-0083; Rodrigues et al. 1993, 24-0084). None of the chemical tracers are considered hazardous at the low quantities used, and the radioactive tracers have very short half lives (35 hours for ^{82}Br and eight days for ^{131}I) and are also not considered hazardous.

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Executive Summary

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3.0 ENVIRONMENTAL SETTING

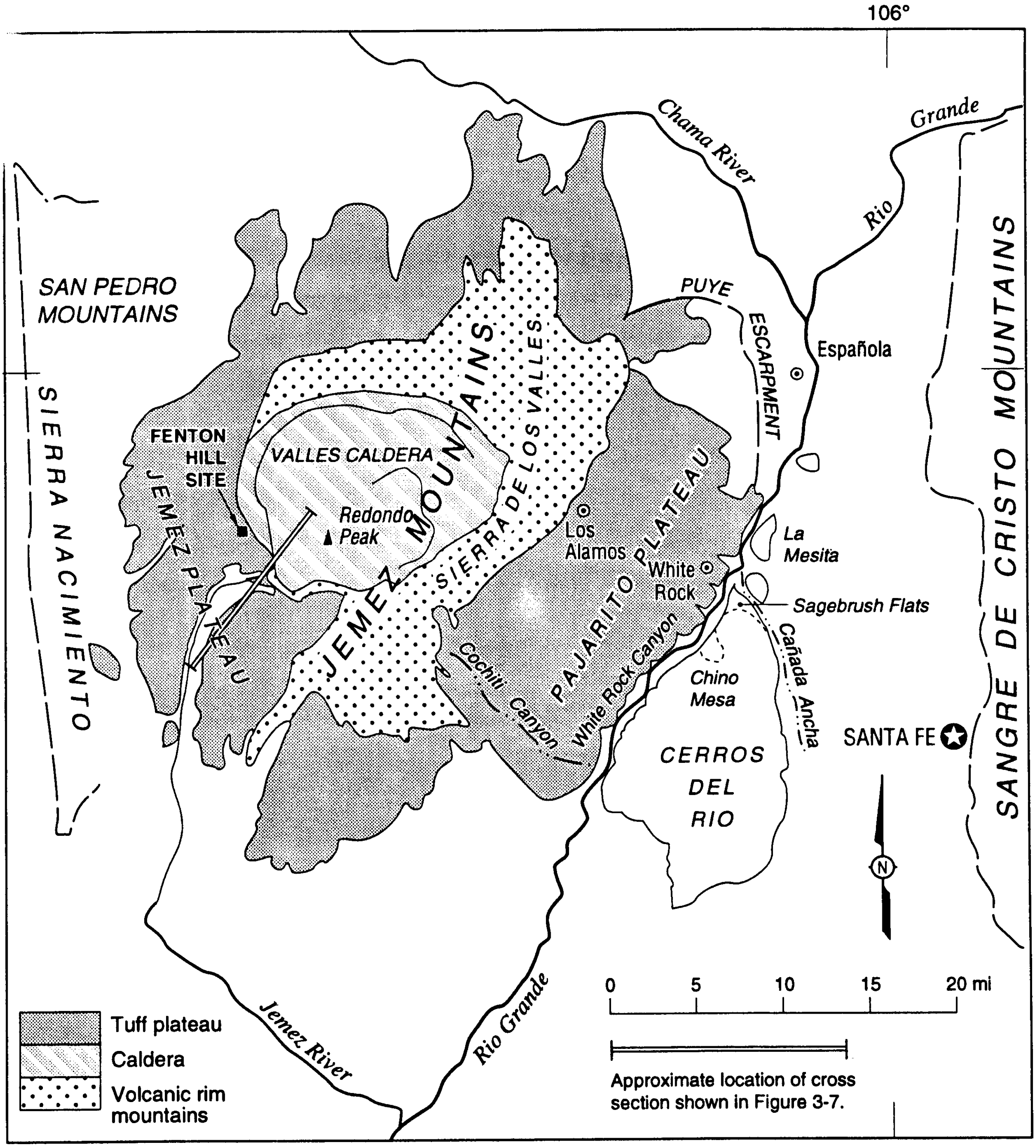
3.1 Physical Description

Technical Area 57 is situated on the Jemez Plateau on the southwest side of the Jemez Mountains, about 60 km (37 mi) west of Los Alamos (Figure 3-1). The Jemez Mountains are dominated by a volcanic depression called the Valles caldera. The Jemez and Pajarito Plateaus are formed of tuff that was ejected from the caldera with sufficient velocity to escape the caldera rim, falling to earth outside the rim and forming an encircling tuff blanket.

The elevations of mountains bounding the Jemez Plateau on the east and west range from 3048 m (10,000 ft) at San Antonio Mountain to a little over 2743 m (9000 ft) along the crest of the Nacimiento Mountains. The major drainage in the area is the Jemez River and its tributaries. The plateau surface is cut into a number of mesas by southwest-trending streams. The Fenton Hill site is on a plateau between two tributaries of the Jemez River, the Rio de Las Vacas and San Antonio Creek (Figure 2-1). A high ridge along the eastern side of the plateau is parallel to San Antonio Creek and forms part of the western rim of the caldera . Otherwise the surface of the plateau slopes gently downward to the west and southwest. The elevation of the area ranges from 2440 to 2740 m (8000 to 9000 ft) along the crest of the ridge to about 2130 to 2440 m (7000 to 8000 ft) where the plateau terminates in steep slopes or cliffs above the Rio de Las Vacas.

The main site, TA-57, is just off State Route 126 past the nearest town of La Cueva. Technical Area 57 is a typical industrial site combined with an oil field-type drilling operation to tap the geothermal resource. The site is surrounded by a 12-ft high chain link fence with several locked entrance gates. The main gate off Route 126 is guarded 24 hours a day to limit access to the site to Laboratory employees, contractors, and approved visitors. Regular patrols by the site security staff are conducted in consideration of the remoteness of the area, the valuable equipment present, and the potential dangers present at the site—particularly the potential presence of H_2S gas in some areas from the drilling operations.

Inside the fence are well heads GT-2, EE-1, EE-2, and EE-3, which are production facilities used to extract thermal energy from hot rock deep in the earth using



Source: LANL 1992, 0768
Modified by: cARTography by A. Kron 3/15/94.

Figure 3-1. General geographic setting of the Fenton Hill site.

circulating geothermal fluids. Also present are two large ponds for water supply and for storage of excess circulating fluids, various fixed and portable support and administrative structures, and pipe racks and material storage areas. Nearly the entire site has been graded and slopes gently to the southwest. Little of the original land surface remains. Drainage off the site flows in two directions, to the south-southeast into Lake Fork Canyon and to the west-northwest into an unnamed tributary of the Rio Cebolla.

Associated with the activities at TA-57 are two other areas of interest. The original test boring (GT-1) located in Barley Canyon has been converted into a geophysics monitoring station and is located about 2 miles north of TA-57. An U.S. Forest Service gravel pit, located about 2 miles southwest of TA-57, has been used for disposal of sludges from drilling operations and from cleanup of former settling ponds. These sites are shown in Figure 1-3.

Access to the main site is by all-weather roads from Los Alamos to the east and from Jemez Springs and San Ysidro to the south by State Roads (SR) 4 and 126. The GT-1 well site in Barley Canyon is accessible in good weather by U.S. Forest Service Roads 144 and 378. The gravel pit is accessible in good weather by U.S. Forest Service Road 10377.

3.2 Climate

The Jemez Mountains have a semiarid, continental mountain climate typical of most southwestern mountains. The climate is characterized by local convective shower activity during the summer and major regional storms during the winter. The irregular terrain causes irregularities in the storm patterns. Temperatures in the region are generally mild, although extreme diurnal fluctuations in temperature can occur. A weather station was established at the site in 1975, and a preliminary climatological baseline was established over succeeding years.

At Fenton Hill, a ring valley at La Cueva intercepts cold air drainage off Redondo Peak and channels it down the Jemez River valley, bypassing Fenton Hill. Wind directions above ridge tops are most frequently southwesterly, and less frequently westerly through northwesterly. Daytime winds can be highly variable due to orographic effects. Within the canyons, convective circulations are established by greater solar heating of the northern (south-facing) canyon walls. Average wind patterns also have a distinct seasonal shift.

During January the air flow is primarily from the northwest, but the patterns shift as the seasons progress into summer with an almost complete reversal to southeasterly winds by August. Precipitation at the site also follows the pattern expected for semiarid southwestern mountain ranges. A four-year data base is available for precipitation. The average annual precipitation for the years 1976 to 1979 was about 430 mm (17 in.) (Rea 1977, 34-0011; Pettitt 1976, 24-012; Kaufman and Siciliano 1979, 24-0013; and Miera et al. 1984, 24-0014). Rainfall, much of it released in thundershowers, reaches its peak in the months July through September, the "monsoon" season, when an average of 59 mm (2.3 in.) per month was recorded (Barr and Wilson 1981, 24-0085). Hail may accompany the more severe thunderstorms, but damage from large hailstones is infrequent. Flooding is limited to localized flash floods in the canyons. Most of the winter precipitation falls as snow, the annual average snowfall being about 2600 mm (100 in.) (Pettitt 1976, 24-0012).

Temperatures recorded at Fenton Hill are observed to be somewhat colder than the summer and winter temperatures recorded at Los Alamos; however, according to Pettitt (1976, 24-0012), the temperature patterns at Fenton Hill are generally the same as at Los Alamos. Maximum daytime temperatures at Los Alamos exceed 32°C (90°F) on an average of only two days per year. Freezes have been recorded in all months except July and August. Winters are cold, but at this elevation warming under cloudless skies is rapid even in winter. During January, the coldest month, daytime temperatures can generally be expected to be above 0°C (32°F), and an average winter includes only 18 days when the temperature stays below freezing. Winter nighttime temperatures drop below freezing from November through mid-April, but readings below -18°C (0°F) occur only about once a year.

3.3 Biological and Cultural Resources

Environmental studies begun in 19[illegible] have provided baseline information on the biological resources of the area. Also, during 1993, field surveys were conducted by the Biological Resource Evaluations Team (BRET) of the Laboratory's Environmental Protection Group for OU 1154 to provide information on the biological resources before site characterization. Further information concerning the biological field surveys for OU 1154 will be contained in the full report "Biological Assessment for Environmental Restoration Program, Operable Unit 1154" (Keller in prep, 24-0074). This report will provide specific information on survey methodology, results, and mitigation measures and will also contain information that may aid in defining ecological pathways and site restoration.

The purpose of the surveys conducted by the BRET at OU 1154 was threefold. The first was to determine the presence or absence of any critical habitat for any state- or federal-sensitive, threatened, or endangered plant or animal species within the OU boundaries. Second, surveys were conducted to identify the presence or absence of any sensitive areas such as flood plains and wetlands that may be present within the areas to be sampled, the extent of the areas, and their general characteristics. The third purpose was to provide additional plant and wildlife data concerning the habitat types within the OU.

3.3.1 Threatened, Endangered, and Sensitive Species

As a result of the habitat evaluation and previous data on OU 1154, there are at least eight species of concern for this OU (Hubbard et al. 1978, 24-0067). These are the spotted bat, the northern goshawk, Mexican spotted owl, Jemez Mountain salamander, the pine martin; the wood lily, the checker lily, and the Sandia alumroot. See Table 3-1 for the listing of these species and their status on the federal and state lists.

TABLE 3-1

Threatened, Endangered, And Sensitive Species

Species of Concern for OU 1154

Species		**Status**	
Common name	Latin name	Federal	State
Northern goshawk	*Accipiter gentilis*	candidate	
Mexican spotted owl	*Strix occidentalis lucida*	candidate	
Spotted bat	*Euderma maculatum*	threatened	endangered
Pine martin	*(Martes americana)*	candidate	endangered
Jemez Mountain salamander	*Plethodon neomexicanus*	candidate	endangered
Wood Lily	*Lilium philadelphicum* var. *andium*		endangered
Checker Lily	*Fritillaria atroupurpurea*		sensitive
Sandia Alumroot	*Heuchera pulchella*		sensitive

The spotted bat is found in piñon-juniper, ponderosa, mixed conifer, and riparian habitats. The two critical requirements for the spotted bat are a source of open surface water and roost sites (caves in cliffs or rock crevices). Fenton Hill and the small canyons surrounding this location should have a number of potential roost sites. Suitable surface water would be small ponds or pools of slow-moving water. Natural suitable water sources are limited within the boundaries of this OU; however, manmade ponds may serve as potential water sources. To date, no spotted bats have been successfully mist-netted on Laboratory property.

The northern goshawk's habitat is dense, mature or old-growth coniferous forest, which has been identified at OU 1154. Goshawks have been found within the northwest portions of the Laboratory with the highest percentage of nests (in Los Alamos County) in ponderosa pine/Gambel oak, ponderosa pine/gray oak and mixed conifer habitats (EPA 1991, 24-0064). All of these habitats are found in OU 1154. To avoid adverse impacts to goshawks, machine sampling from May through September will be cleared through BRET, and BRET will be contacted 60 days prior to sampling to evaluate possible nest sites in and around the sampling area.

Habitat requirements for the Mexican spotted owl include uneven-aged, multistory mixed conifer forests with closed canopies in forested mountains and canyons. Tree cavities or abandoned hawk nests are suitable nest locations for the spotted owl, which has been detected in Los Alamos County and at OU 1154. To avoid adverse impact to Mexican spotted owls, any machine sampling occurring between May and October will be cleared through BRET, and BRET will be contacted 60 days prior to sampling to evaluate possible nest sites in and around the specific sampling area.

The Jemez Mountain salamander requires downed and decayed conifer trunks or rocks (talus slopes) in mixed conifer to spruce-fir plant communities. Moist slopes and moderate to heavy overstory cover also are necessary for this small amphibian's survival, so they are found most frequently in areas of closed canopies, north-facing slopes, or near streams and seeps within decaying logs and litter. Suitable habitat for the salamander are found near the boundaries of OU 1154 (Ramotnik 1986, 24-0066).

Due to strict state survey protocols, a species-specific survey for the Jemez Mountain salamander, if deemed necessary, can only be conducted in the summer months after several days of heavy rain (July or August). Sampling for site characterization will begin with BRET approval.

The pine martin (*Martes americana*) is found in spruce-fir habitat, which occurs within the boundaries of OU 1154. The pine martin requires old-growth habitat with canopy cover, fallen logs or hollow trees, and small mammals to feed on. This animal, whose young is born in April, is very susceptible to human disturbance, and vehicular traffic or any activities causing the removal of downed logs, forest litter, or hollow trees will adversely impact pine martin habitat. This animal has not been reported on Laboratory property, but the existence of suitable habitat and the animal's secretive, nocturnal nature provide the possibility of its being in the area of OU 1154. To avoid adverse effect on the pine martin, if any area over one-tenth acre will be disturbed or if any tree removal is planned, BRET will be contacted for a presampling site-specific survey.

Several raptors breed in OU 1154. Travis (1992, 24-0017) reports substantiated observations of breeding pairs in adjacent areas for the American kestrel (*Falco sparverius*), great horned owl (*Bubo virginianus)*, and redtail hawk (*Buteo jamaicensis*). Zone-tailed hawks (*Buteo albonotatus*) and turkey vultures (*Cathartes aura*) are also possible breeders within OU 1154. Although specific nesting species are not confirmed for this area, the proximity of this OU to confirmed nesting locations provides a high probability that these areas are utilized by these raptor species. Potential raptor nest sites and roosts occur in ponderosa pine and mixed conifer forests. Steep cliffs with small caves and rock crevices found in this OU also provide the seclusion and commanding views required for nesting and roosting. From May to September, nesting sites should be free from additional noise, heavy equipment, and activities that could be harassing.

3.3.2 Small mammals

The species most often trapped during the 1976-1979 baseline studies was the deer mouse (*Peromyscus maniculatus*). This has health significance in view of the recent discovery of the hantavirus in the deer mouse population of New Mexico. Other species encountered were: the least chipmunk (*Eutamias minimus),* golden-mantled squirrel *(Spermophilus lateralis),* least weasel *(Mustela rixosa),* desert cottontail *(Sylvilagus audibonii*), and the Mexican woodrat (*Neotoma mexicana.)*

3.3.3 Large animals

The aerial seeding (see Section 3.3.5) of grass makes the area an important wintering range for elk. Other large animals are also commonly found at OU 1154, including mule deer, black-tailed deer, coyotes, black bear, badger, bob cat, and mountain lion.

3.3.4 Small Birds

Forty-one species of birds were identified during 1976 baseline studies. Common bird species encountered during preliminary BRET surveys in the summer of 1993 included: Steller's jay (*Cyanocitta stelleri*), common raven (*Corvus corax*), chipping sparrow (*Spizella passerina*), common grackle (*Quiscalus quiscula*), house finch (*Carpodacus mexicanus*), solitary vireo (*Vireo solitarius*), mountain chickadee (*Parus gambeli*), hermit thrush (*Catharus guttatus*) and Williamson's sapsucker (*Sphyrapicus thyroideus*). Nesting species include: the black-chinned hummingbird (*Archilochus alexandri*), northern flicker (*Colaptes auratus*), yellow-bellied sapsucker (*Sphyrapicus varius*), hairy woodpecker (*Picoides villosus*), Traill's willow flycatcher (*Empidonax traillii*), western wood-pewee (*Contopus sordidulus*), violet-green swallow (*Tachycineta thalassina*), white-breasted nuthatch (*Sitta carolinensis*), pygmy nuthatch (*Sitta pygmaea*), house wren (*Troglodytes aedon*), American robin (*Turdus migratorius*), western bluebird (*Sialia mexicana*), warbling vireo (*Vireo gilvus*), yellow-rumped warbler (*Dendroica coronata*), western tanager (*Piranga ludoviciana*), Cassin's finch (*Carpodacus cassinii*), green-tailed towhee (*Pipilo chlorurus*) and the dark-eyed junco (*Junco hyemalis*).

3.3.5 Vegetation

Based on the 1976-1979 baseline studies and the 1993 preliminary BRET survey, three major vegetative complexes are found at Fenton Hill. Typical climax vegetation found at a 2600-m elevation in northern New Mexico is a mixed conifer forest with spruce and fir dominating at higher elevations and ponderosa pine dominating at lower elevations. A wildfire in 1971 destroyed part of this climax vegetation at and surrounding TA-57. The fire scar was aerially seeded with a mixture of pasture grasses and legumes shortly after the fire, and one year later, ponderosa pine seedlings were planted 3- to 5-m apart. Many of the species found in the 1993 survey could have resulted from secondary succession in the areas affected by the fire. The presently dominant vegetation consists of grass and forbs interspersed with aspen (Rea 1977, 24-0011).

The dominant trees within the overstory vegetation were found in the survey to be the aspen (*Populus tremuloides*), ponderosa pine (*Pinus ponderosa*), Douglas fir (*Pseudotsuga menziesii*), and the white fir (*Abies concolor*). The shrubs within this OU are primarily composed of the New Mexico locust (*Robinia neomexicana*), Gambel oak (*Quercus gambelii*), and the western black chokecherry (*Prunus virginiana* var. *melanocarpa*). The dominant understory vegetation was found to be: bearberry (*Arctostaphyios uva-ursi*), orchard grass (*Dactylis glomerata*), sheep fescue (*Festuca ovina*), creeping barberry (*Berberis repens*), bluegrass (*Poa* spp.), western yarrow (*Achillea millefolium* var. *lanulosa*) and groundsel (*Senecio* spp.)

3.3.6 Cultural Resources

As required by the National Historic Preservation Act of 1966 (as amended), a cultural resource survey was conducted during the summer of 1993 at OU 1154 (Albertson and Hoagland in prep., 24-0016). The methods and techniques used for this survey conform to those specified in the Secretary of the Interior's Standards and Guidelines for Archeology and Historic Preservation (EPA 1983, 24-0018).

No archaeologhical sites are located in the areas surveyed. Three previous surveys within the area also report no archaeological sites (Scheick 1979, 24-0019; Larson 1987, 24-0020; Larson 1987, 24-0021).

3.4 Geology

Two major volcanic eruptions in the Jemez Mountains that occurred about 1.5 and 1.1 million years ago produced widespread and voluminous ash flow sheets, now called the Otowi and Tshirege members of the Bandelier Tuff (Smith and Bailey 1966, 0377; Spell et al. 1990, 0607). The morphology of the Jemez Plateau is dominated by a gently westward-sloping surface, formed on top of the Bandelier Tuff, which is dissected by numerous steep-sided canyons (Figures 3-2 and 3-3).

The Otowi and Tshirege members of the Bandelier Tuff were erupted concomitant with the collapse of the Toledo and Valles calderas, respectively. The older Toledo Caldera occupied the same site as the Valles caldera but may have been slightly larger. Following formation of the calderas, volcanism continued with the extrusion of domes along ring

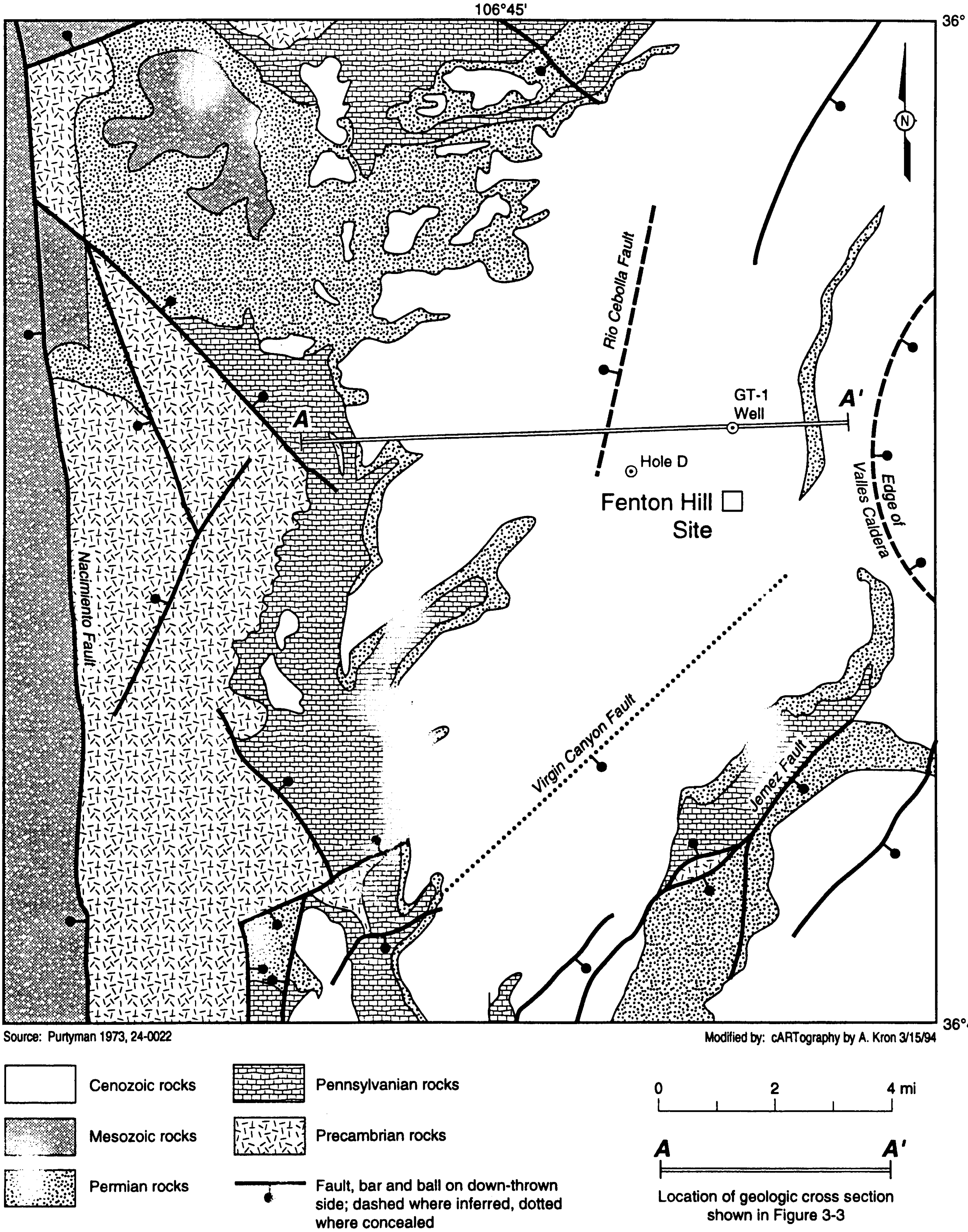


Figure 3-2. Geologic map of the Jemez Mountains west of Valles Caldera.

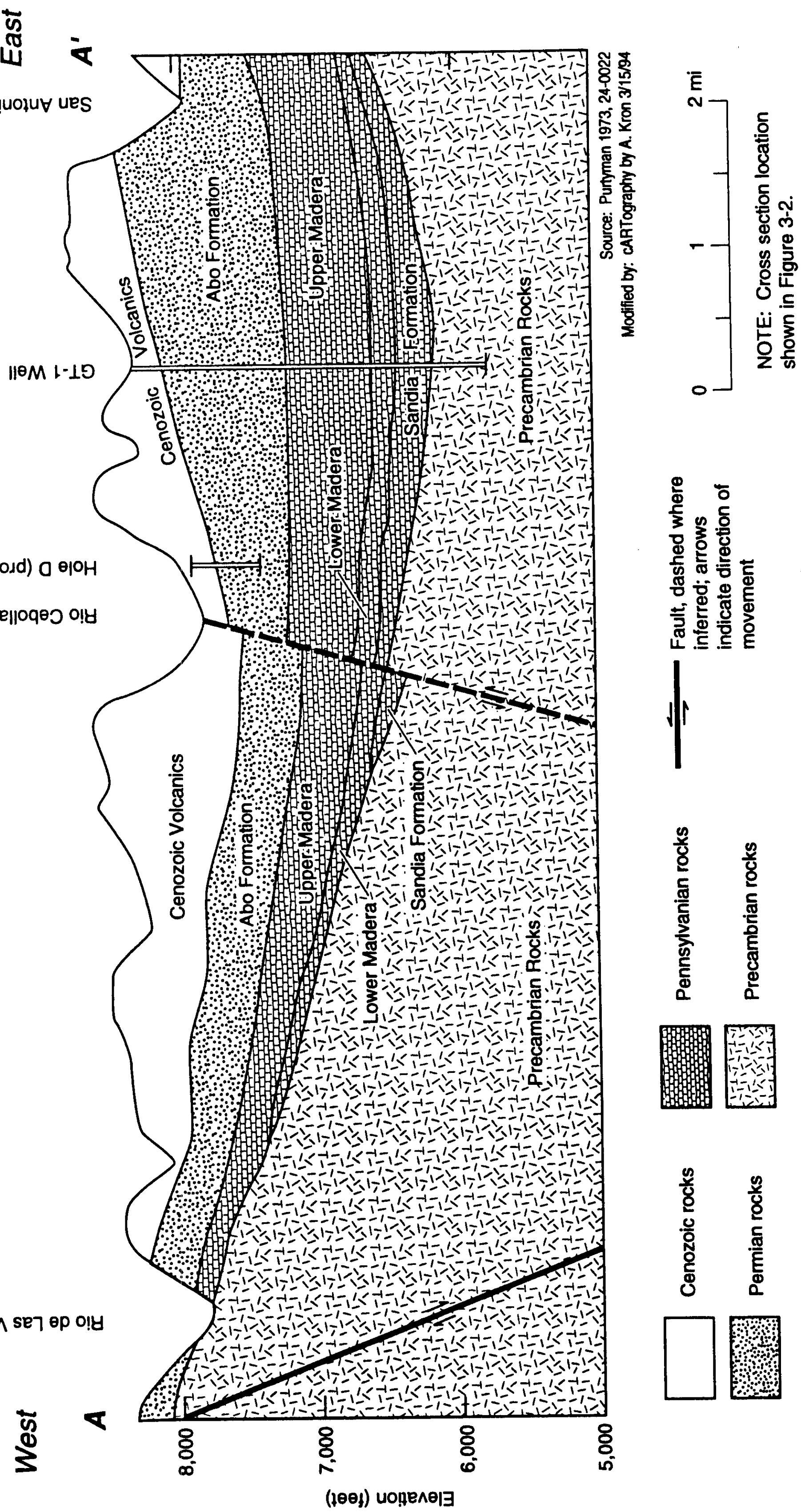


Figure 3-3. Geologic cross section of the Jemez Plateau west of Valles Caldera.

fractures. The latest eruption in the Jemez Mountains occurred about 130,000 years ago, producing the El Cajete pumice, which occurs on Cat Mesa about 13 km south-southeast of Fenton Hill, and the Banco Bonito rhyolite flow, which occurs near La Cueva about 4 km southeast of Fenton Hill (Gardner et al. 1986, 0310; Self et al. 1988, 0500). No deposits from this eruption are present at the Fenton Hill Site. Vestiges of volcanic activity continue today, as evidenced by hydrogen sulfide emissions and hot spring activity both within and outside the Valles caldera (Goff et al. 1989, 0774). Seismic studies of P-wave arrival times suggest the presence of partially molten rock below the Valles caldera, possibly remnants of a cooling Bandelier magma chamber (Roberts et al. 1991, 0775).

Sierra Nacimiento to the west of Fenton Hill is a Precambrian to Paleozoic fold mountain of Laramide origin (Kelley 1978, 0641), partially obscured under the Pleistocene volcanics of the Jemez Mountains. The Precambrian rocks are predominantly quartzite, granite gneiss, schist, and greenstone. Overlying the Precambrian are Carboniferous to Permian marine limestones, sandstones, and shales (redbeds).

3.4.1 Bedrock Stratigraphy

Precambrian granite and gneiss crop out along the flanks and crest of the Nacimiento Mountains. These are overlain by Pennsylvanian and Permian limestones, sandstones, and shales. Mesozoic sediments crop out in the northwestern part of the area and on the western slopes of the Nacimiento Mountains, but do not extend to the east below the Jemez Plateau (Purtymun 1973, 24-0022). The Cenozoic volcanic rocks form the upper surface of the Jemez Plateau, overlying the Permian, Pennsylvanian, and Precambrian rocks (Kaufman & Siciliano 1979, 24-0013). A geologic column of the region near the site is shown in Figure 3-4. Cenozoic volcanic rocks fall into two age groups. Those exposed at the surface are called Bandelier Tuff, and the buried volcanics are the Paliza Canyon Formation and Abiquiu Tuff. The Tshirege member forms the uppermost layer of the Bandelier Tuff at Fenton Hill.

The Bandelier Tuff is a nonwelded to densely welded rhyolite tuff that ranges from light to dark gray. It is composed of quartz and sanadine crystals, lithic fragments of latite and rhyolite, and fragments of glass shards and rare mafic minerals in a fine-grained ash matrix. This tuff layer thins to the west and southwest away from its source at the Valles caldera (Rea 1977, 24-0011; Kaufman & Siciliano 1979, 24-0013). The Bandelier Tuff is about

FENTON HILL STRATIGRAPHY					
Age	**Era**	**Period**	**Depth**	**Formation**	**Temp.**
	CENOZOIC	Quaternary		Bandelier Tuff	46°F 8°C
2.5my	CENOZOIC		50ft 15m		53°F 12°C
	CENOZOIC	Tertiary		Paliza Canyon Abiquiu Tuff(?)	
68my		unconformity	460ft 140m		86°F 30°C
	PALEOZOIC	Permian		Abo red beds	
280my	PALEOZOIC		1,250ft 381m		125°F 52°C
	PALEOZOIC	Pennsylvanian-Mississippian		Madera Limestone Sandia Formation(?)	
345my? 570my+		unconformity	2,405ft 733m		190°F 88°C
1,300 to 1,700 my	PROTEROZOIC	Precambrian		Fenton Hill granodiorite (intrusive) Metamorphic and igneous complex (undifferentiated)	
	PROTEROZOIC		15,000ft 4,572m		608°F 320°C

Source: Nuckols et al. 1981, 24-0025
Modified by: cARTography by A. Kron 2/1/94

Figure 3-4. Geologic column of Fenton Hill stratigraphy.

106-m (350-ft) thick under the Fenton Hill site (Purtymun, West, and Pettitt 1974, 24-0024). The Paliza Canyon Formation underlies the Bandelier Tuff and is composed of andesite and basaltic andesite breccias that are interbedded with sand and gravels. The Paliza Canyon Formation is about 15-m (50-ft) thick under the site (Purtymun et al. 1974, 24-0024). Under the Paliza Canyon is the Abiquiu Tuff, which is a light gray, friable tuffaceous sandstone. It is about 15-m (50-ft) thick under the site (Purtymun et al. 1974, 24-0024).

Underneath the Abiquiu Tuff are the Permian redbeds of the Abo Formation. The lithologies are typically arkosic siltstone, sandstone, and shale. There are small inclusions of calcareous gray clay. Particles include granules of quartz and feldspar and pieces of igneous rock. The thickness is highly variable due to erosion prior to Cenozoic volcanism (Rea 1977, 24-0011; Kaufman & Sicilano 1979, 24-0013).

Beneath the Abo Formation are Pennsylvanian limestones, shales, and arkoses of the Magdalena group. The group consists of Madera limestone over the Sandia Formation. The Madera limestone is an arkosic limestone containing both gray and red arkosic shale overlying a dark gray limestone with insets of gray shale and beds of sandstone. The Sandia Formation has an upper clastic member of sandstone, shale, and limestone. The lower part is a discontinuous dark gray siliceous limestone (Rea 1977, 24-0011; Kaufman & Siciliano 1979, 24-0013).

The basement beneath the Sandia Formation is a coarse Precambrian granite with large microcline crystals, quartz-feldspar lenticular gneiss, schists, amphibolites, and pegmatites. Veins include quartz and hornblendite. Minerals include quartz and microcline, oligoclase-andesine, hornblende, biotite, epidote, sphene, apatite, zircon, ·anite, tourmaline, and magnetite (Rea 1977, 24-0011; Kaufman & Siciliano 1979, 24-0013; Laughlin et al. 1983, 24-0023).

3.4.2 Structure

The structural geology of the Fenton Hill site can be addressed on three general scales: regional, local, and immediate. On the regional scale, several major features dominate (Figure 3-5). The Nacimiento fault, or lineament, separates the Precambrian to Paleozoic rocks on the east from the younger sediments of the San Juan Basin. The Valles caldera

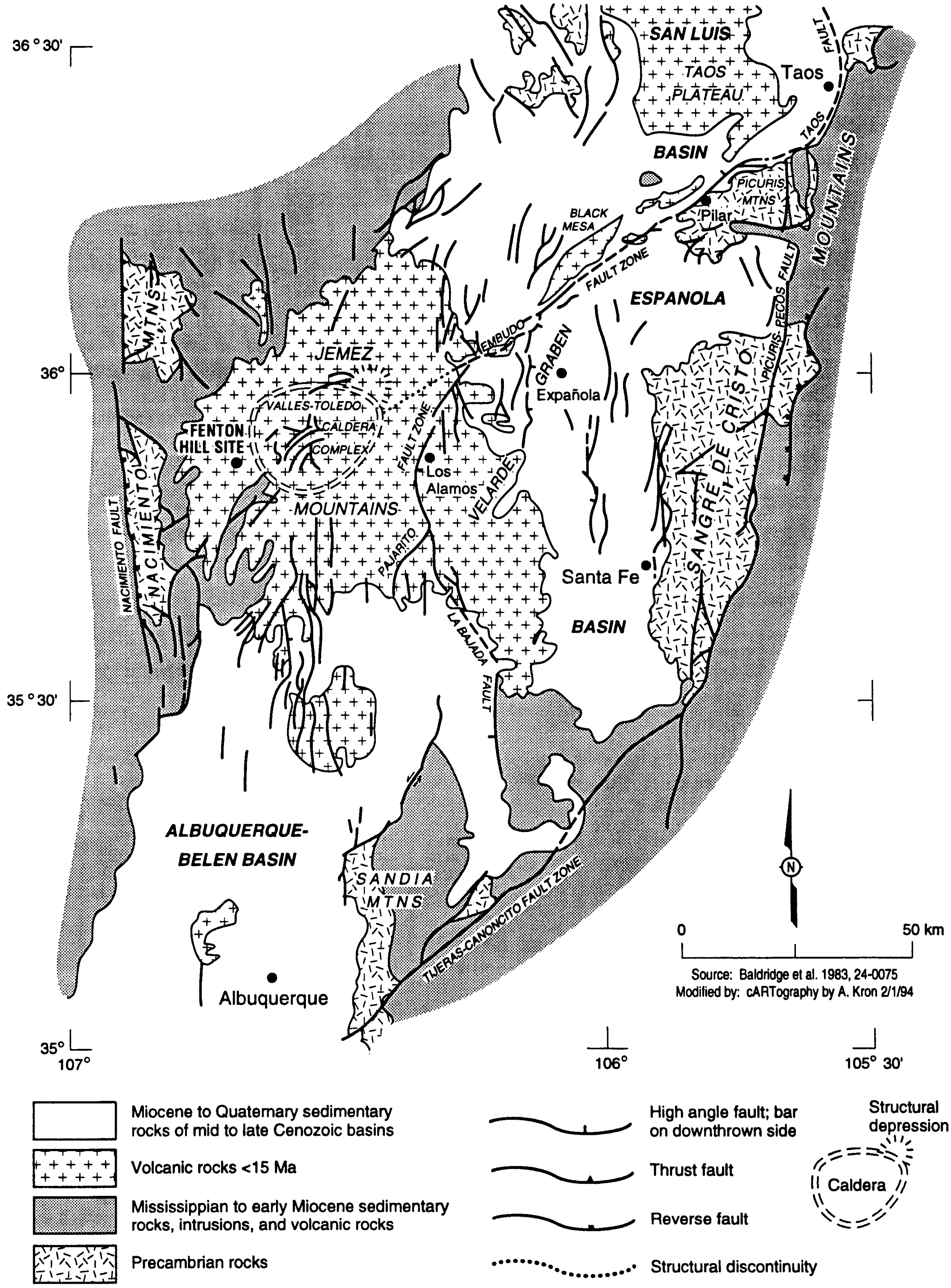


Figure 3-5. Generalized geologic map of the Jemez Mountains.

and the ring faults that define the caldera perimeter lie to the northeast of the site. On the east side of the Jemez Mountains, the range is bordered by the Pajarito fault zone.

Locally, faults of interest are the inferred fault that defines the course of the Rio Cebolla, the Virgin Canyon fault, and the Jemez fault (Figure 3-2). A few additional faults have been inferred from geologic and geophysical information just to the north of Fenton Hill. One example is a fault that may parallel the upper course of San Antonio Creek and may localize geothermal water at San Antonio Hot Springs. Others, such as the Virgin Canyon fault, have been identified in the underlying Madera and Abo Formations but apparently do not extend into or through the overlying volcanics. While these faults may localize springs along the canyon walls and could act as channels for contaminant migration, they are not mapped as intersecting the surface in the near vicinity of the site (Kintzinger and West 1976, 24-0026; Slemmons 1975, 24-0027; Kintzinger et al. 1978, 24-0028).

3.4.3 Surficial Deposits

Very little remains of the original surficial material at TA-57 and at the U.S. Forest Service gravel pit, which was used as part of the geothermal operations as a sludge dumping site. The Barley Canyon site is a typical high-mountain intermittent stream channel with stream channel deposits.

3.4.3.1 Alluvium and Colluvium

A thin veneer of physically weathered bedrock colluvium is the only surficial material left in the few undisturbed areas of OU 1154. The residual material is thicker on the top of the plateau and thins along the edges to bedrock outcrops on the steep portions of the canyon walls. There is some fine-grained to coarser material in the two small alluvial channels draining the site to the southeast and northwest; however, these channels have been considerably altered by activities related to site construction and operations.

This is also true of the sludge disposal site at the U.S. Forest Service gravel pit about 2 miles west of the site. The Barley Canyon site is directly in the bottom of a small intermittent stream channel, which is dry much of the year. The channel is coarse alluvium overlain by er alluvium, and the area is vegetated with grass, a few low shrubs, and a few trees.

3.4.3.2 Soils

No exhaustive study of the soils in this high mountain area has been published based on a search of literature. Undisturbed soils are probably typical of the soils described by Nyhan and others (1978, 0161) for the plateau tops and edges in the Los Alamos area. The parent material is the Bandelier Tuff and the processes forming soils should have been very similar to the processes forming soils in the Los Alamos area. For most of TA-57 and for the U.S. Forest Service gravel pit there is no original soil remaining. At Barley Canyon, a humus-rich soil has formed in the bottom of the canyon because of the apparent lack of high-energy run-off and the heavily forested nature of the surrounding slopes. The thickness of the alluvium in Barley Canyon is not known but is estimated to be 2 to 6 ft.

3.4.3.3 Erosional Processes

Erosion at Fenton Hill is largely controlled by the extensive grading of the site to level it for the research activities. Run-off that occurs is channeled into two drainage ways to the south-southeast and to the north-northwest. Little erosion was observed in the northern drainage. Minor erosion, probably caused by channeled flow from adjacent parking areas and storage yards, has caused minor, localized downcutting in the southern drainage (Burns Swale). The thickness of the alluvium at the Fenton Hill site is not known but is estimated to be 1 to 3 ft.

No evidence of significant erosion was observed at the U.S. Forest Service gravel pit sludge disposal area. That area has been heavily graded and is relatively flat. The area of sludge disposal has been bermed for run-on and run-off control.

No significant erosion was observed at the Barley Canyon site. The bottom of the canyon is well vegetated, and no rills or gullies were observed.

3.5 Hydrogeology

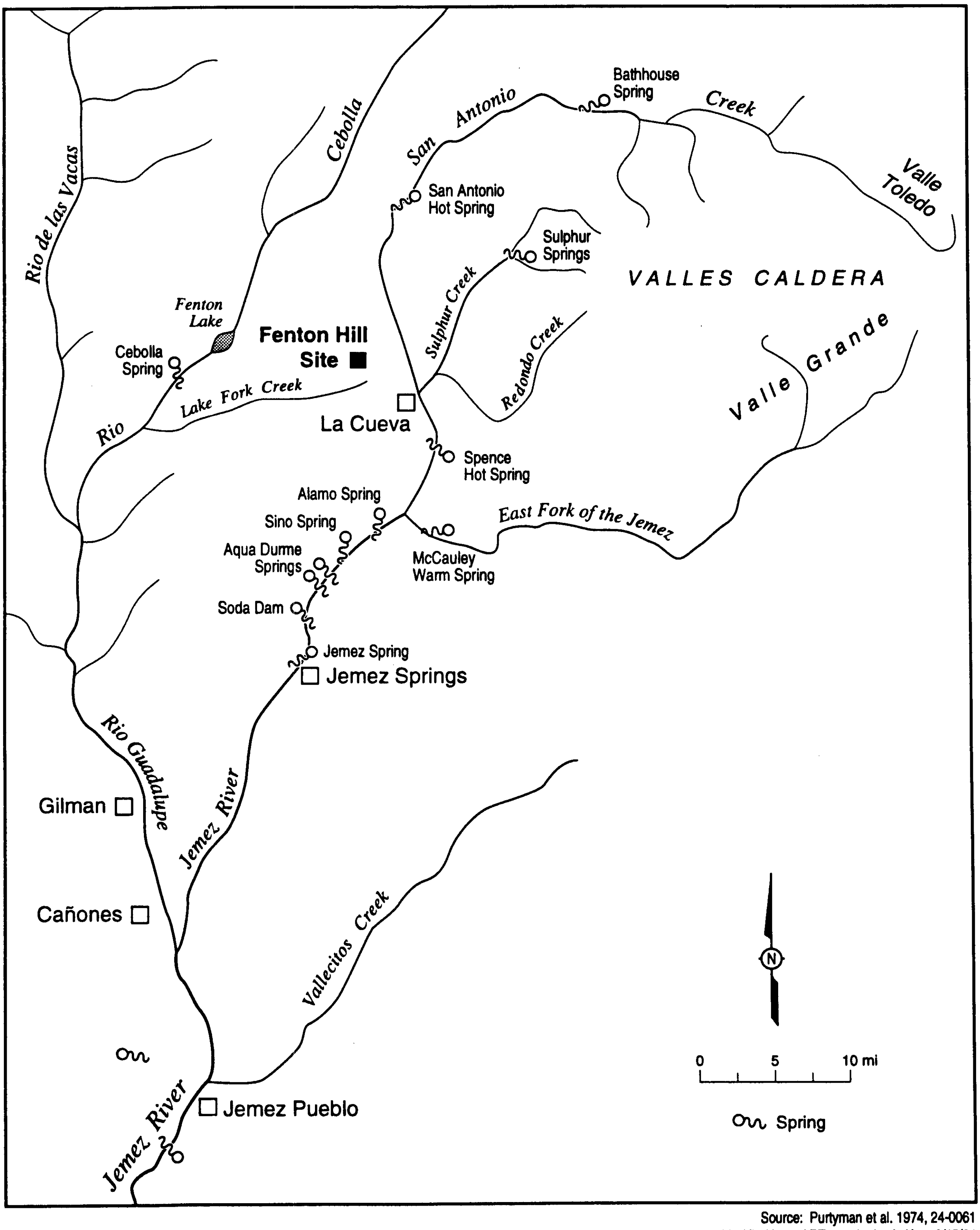
3.5.1 Surface Water Hydrology

The major surface water drainage near Fenton Hill is the Jemez River and its tributaries. (Figure 3-6). The East Fork of the Jemez River drains the Valle Grande. Analyses of the water from the East Fork of the Jemez River show low-dissolved solids, generally less than 100 mg/l. Base flow is from discharge of groundwater to the stream from the near-surface water table in the Valle Grande and from the large amount of precipitation that occurs in the high mountains around the Valles caldera.

San Antonio Creek drains the Valle Toledo to the north of the Valle Grande as well as an area along the west side of the Valles caldera and is a tributary to the Jemez River at the confluence with the East Fork of the Jemez River. Several thermal springs discharge into the creek. Sulphur Creek is tributary to San Antonio Creek. The Sulphur Springs are hot springs that occur along upper Sulphur Creek. Analyses of water from Sulphur Creek show moderate concentrations of dissolved solids (greater than 500 mg/l). Base flow in San Antonio Creek is from the discharge of groundwater from the near-surface water table in Valle Toledo and from precipitation. Dissolved solids concentrations in San Antonio Creek are generally low; however, the discharge of water from thermal springs and Sulphur Creek tends to increase the dissolved solid concentrations in a downstream direction from about 100 mg/l to 200 mg/l. In general, the water quality improves downstream of the geothermal area due to dilution by inflow of fresh groundwater and run-off from precipitation.

At the confluence of the East Fork of the Jemez River and San Antonio Creek the combined streams become the Jemez River. Downstream, the Jemez River mineral concentration tends to increase due to the inflow of highly mineralized water from thermal springs.

The Rio Guadalupe drains the area west of Fenton Hill and includes the tributaries Rio de las Vacas and Rio Cebolla. The Rio de las Vacas drains an area west of the Valles caldera. Dissolved solids are low and increase downstream (Purtymun et al. 1974, 24-0061). Base flow to the Rio Cebolla is from groundwater discharge from the shallow alluvial aquifers



Source: Purtyman et al. 1974, 24-0061
Modified by: cARTography by A. Kron 3/15/94

Figure 3-6. Surface water drainages and selected spring locations near Fenton Hill site.

along numerous tributaries and from springs on the canyon walls. The dissolved solids in the system increase downstream; however, their concentrations are low.

The Fenton Hill site slopes gently south so the major part of the run-off is into Lake Fork Creek, which is tributary to the Rio Cebolla below Fenton Lake. The land immediately northwest of TA-57 drains into an unnamed tributary, which joins the Rio Cebolla at Fenton Lake. The land immediately northeast of TA-57 drains toward San Antonio Creek, but is diverted by a low divide into Lake Fork Creek.

3.5.2 Groundwater

Groundwater occurs in the sediments in the Valles caldera and as perched water in volcanic rocks and sediments adjacent to the caldera. Water supply is from springs at the community of Jemez Springs and from a well at another community, Jemez Pueblo, both situated downstream. Other small communities and isolated homes also draw water from wells and springs. Water for domestic and recreational use at other smaller communities and isolated homes is obtained from shallow wells completed in the alluvium of stream channels or from springs.

The major geothermal flow regime is a structurally controlled part of the deep regional aquifer, as illustrated in Figure 3-7. Fluids from deep within the caldera exit through the Jemez fault zone. The principal pathway is through cavernous Paleozoic limestone overlying low-permeability Precambrian rocks. (Goff et al. 1989, 0774). The aquifer perched on the Abo Formation (Figure 3-3) produces cold clean water and is the source tapped by most of the domestic wells in bedrock. At the Fenton Hill site, the aquifer perched on the Abo Formation lies at a depth of about 450 ft. Other less significant perched water can be found at greater and lesser depths. The regional aquifer lies beneath the perched aquifers and occurs at a depth of aabout 1750 ft beneath the site.

3.5.2.1 Vadose Zone

The vadose zone underlying TA-57 is in thin, surficial soil deposits and in the underlying volcanic tuff. Flow and transport in the vadose zone will be mainly downward to the perched water at the base of the volcanics.

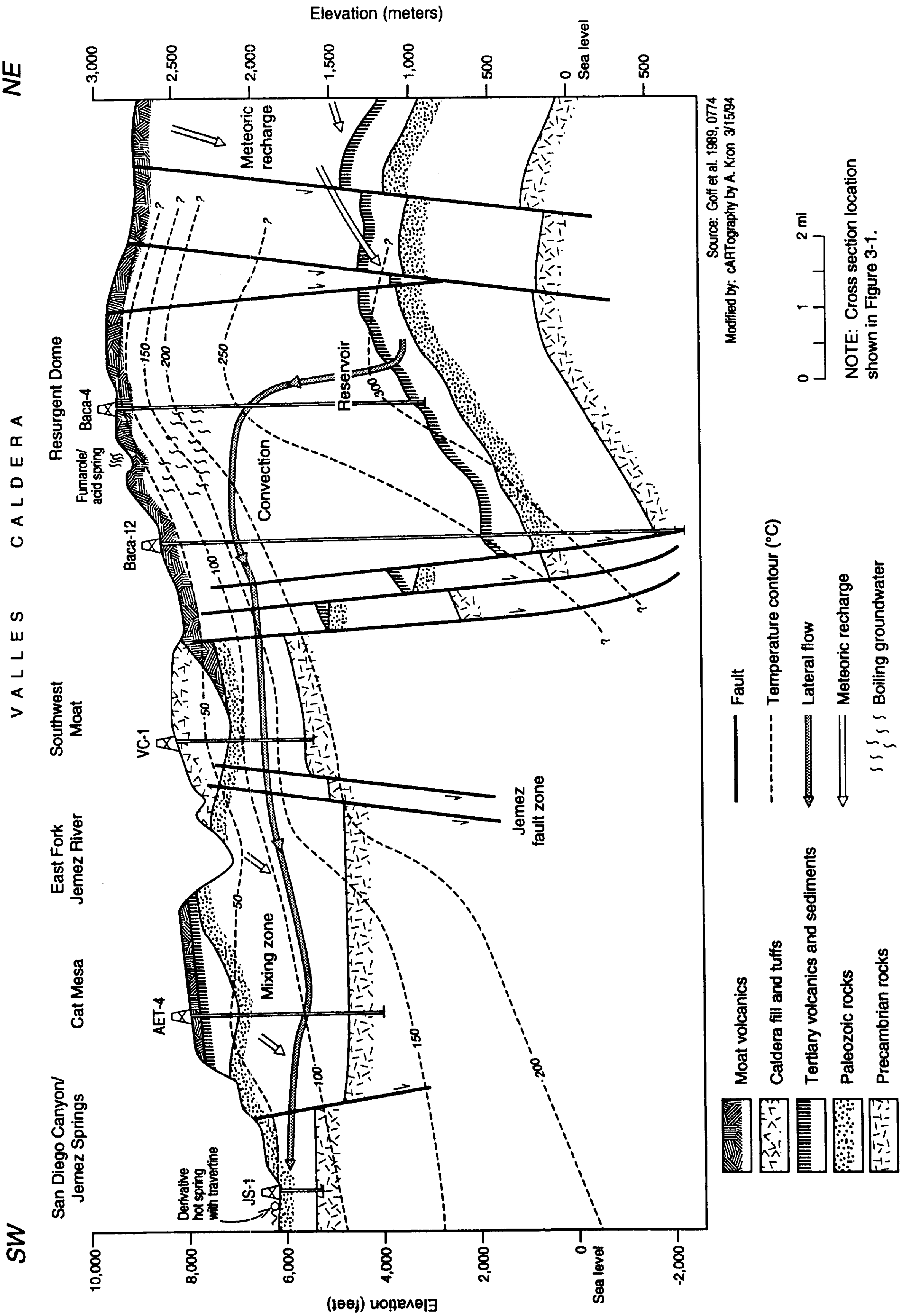


Figure 3-7. Patterns of deep geothermal flow in the Valles Caldera.

3.5.2.2 Saturated Alluvium

Burns Swale, a dry tributary of Lake Fork Canyon, has a 2- to 6-ft depth of alluvium in its upper reaches and more than a 40-ft depth of alluvium at the confluence with Lake Fork Canyon. In May 1979, water was encountered in four holes bored in the alluvium. Later in the year, these holes were dry (Kaufman and Siciliano 1979, 24-0013). After a release of water into Burns Swale in September of 1979, the two holes closest to the site again contained water. Releases to Burns Swale were observed to infiltrate into the alluvium and then would have either moved downstream along the interface of the alluvium and the Cenozoic volcanics or infiltrated into the volcanics.

There is also a small valley fill in Barley Canyon. The drilling pit at the GT-1 site was excavated in that alluvium, which would be saturated only during periods of high run-off. Alluvial aquifers in the adjacent major rivers, such as the Jemez River, Rio Guadlupe, and Rio Cebolla, are the most permeable units in the area.

3.5.2.3 Perched Aquifers

Kaufman & Siciliano (1979, 24-0013) identified an aquifer at the base of the Cenozoic volcanics. This volcanic aquifer is perched on the Abo Formation, which consists of Permian redbeds that act as an aquitard to any downward percolation. Many of the springs in the area emerge at the volcanics/red bed contact. Goff and others (1989, 0774) indicate that the shallow groundwater outflow from the caldera is along this horizon.

Groundwater in this perched aquifer appears to be confined to buried stream channels at the Cenozoic-Paleozoic (Abo) contact. The Cenozoic volcanics were deposited on a well-developed erosional surface cut into the Abo. It has been observed that some of the springs discharge from the volcanics at the outcrop of ancient drainage channels in the Abo Formation (Figure 3-8). The locations of these discharges suggest that the buried Abo drainage system controls the principal flow of groundwater in the overlying volcanics. The general absence of rows of springs along the outcrop of volcanics implies that the saturated zone in the volcanics does not extend much above the top of the drainage channels. This was substantiated by two test holes that were dry in the volcanic section of the holes (Kaufman & Siciliano 1979, 24-0013).

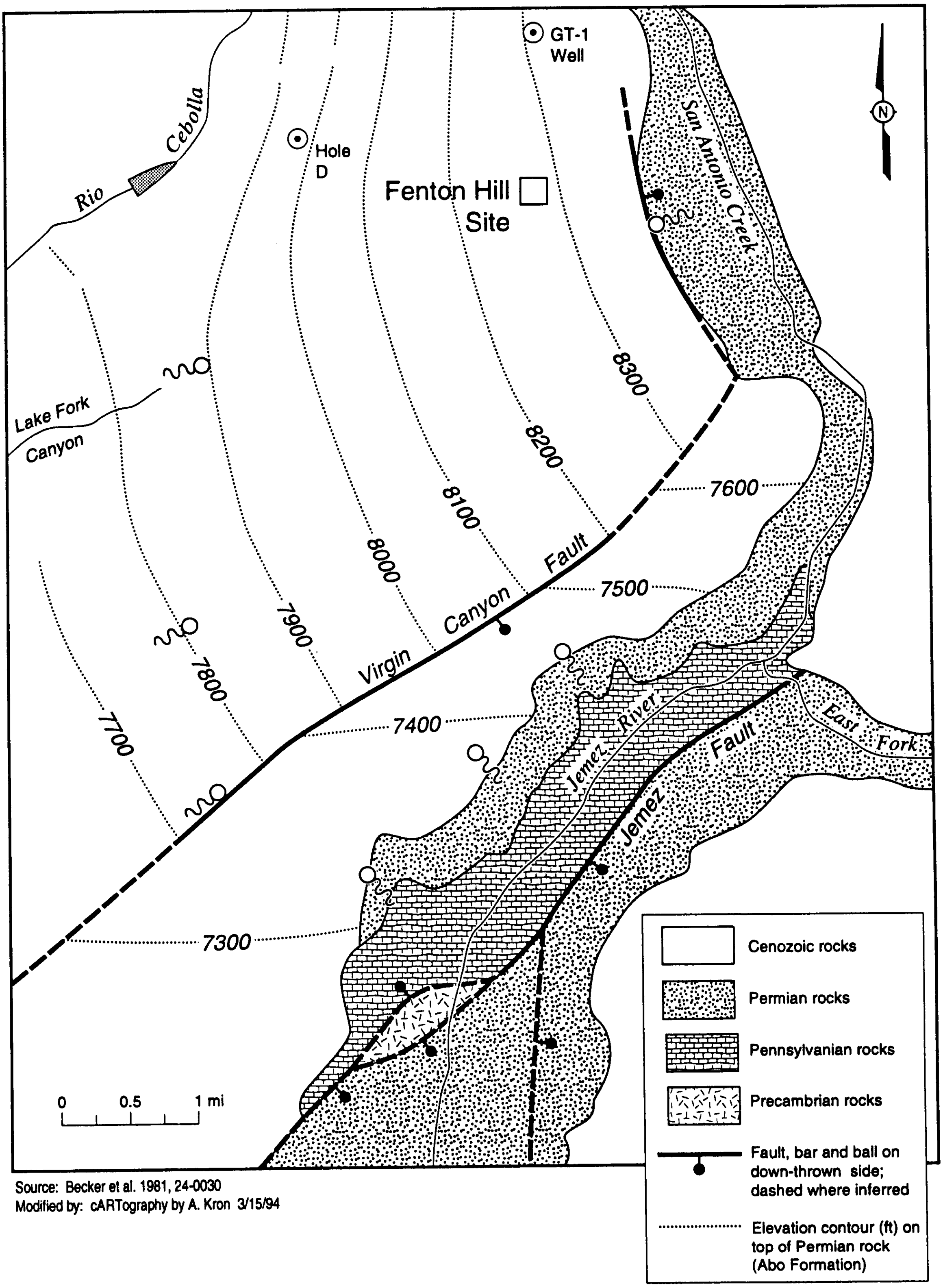


Figure 3-8. Generalized geologic map of the Fenton Hill site showing the surface of the Abo Formation.

The water supply (domestic and experimental use) for Fenton Hill is furnished by well FH-1 completed in a perched aquifer at a depth of about 136 m (450 ft). The aquifer is in the Abiquiu Tuff and is perched on the clays and siltstones of the Abo Formation. The aquifer is of limited extent, terminating to the east along the canyon cut by San Antonio Creek. Water movement in the aquifer is to the southwest, where a part is discharged through springs and seeps in the lower part of Lake Fork Canyon and along the Rio Cebolla (Figure 3-8).

Millions of gallons of highly mineralized, very hot water were circulated under great pressure from the surface to a depth of about 15,000 ft and up again as part of the HDR project. Any failures in the steel casing or cement seals could lead to leakage. The possibility of leakage was recently reviewed by examining the heat loss from fluids ascending the deep wellbores under geothermal gradients Principal leakages were inferred at two locations high in the old GT-2 wellbore. One leak was calcuated to be at a depth of 120 ft and the other to be over the interval of 390 to 420 ft. Both leaks are in the Tertiary Paliza Canyon breccias or Abiquiu Tuffs. The rate of loss is estimated at 1 to 2 gpm. The Fenton Hill wells were installed and are continuing to be operated under the regulations of the New Mexico Division of and Gas, and, as such, they are not addressed under this work plan.

Very few springs or wells produce from the Abo. Aquifers in the Abo are lenticular sandstones. It is likely that because these are disconnected lenses, aquifers in the Abo are confined, disconnected, and not part of a general aquifer system. At TA-57, the Madera Formation underlies the Abo Formation at a depth of 375 m (1230 ft). The geophysical logs suggest several perched aquifers in this formation.

3.5.2.4 Regional Aquifer

The regional aquifer is at the base of the Madera formation. Many of the hot springs in the region appear at outcrops of this horizon. These are generally hot mineral springs. The regional aquifer is encountered at a depth of 533 m (1750 ft) below TA-57. All of the aquifers above this depth are perched. Within the regional aquifer, a permeable horizon was found in the depth interval 540-550 m (1770-1800 ft). It consisted of 9.1 m (30 ft) of arkosic sandstone or granite wash. Geophysical log data indicate that the zone is "only fair" as an aquifer. Water in the granitic basement is primarily contained in fracture porosity.

3.5.2.5 Water Quality

Water quality has been a concern for geothermal development in the Jemez Mountains from early in the project (Purtymun et al. 1974, 24-0061; Pettitt 1976, 24-0012; Langhorst 1980, 24-0032). Purtymun and others, for example, compiled pre-1971 analyses of records and also field analyses from 1971 to 1973 to document a water quality background for the project. The pattern that emerged from the study shows that the streams of the region have low levels of dissolved solids, which is a general measure of water quality. These values increased downstream, as was expected. Several streams were found to have high-dissolved solids in the vicinity of and downstream from mineral-rich springs. This was particularly notable in the Jemez River near springs associated with the Jemez fault. During periods of low flow along Sulphur Creek, high levels of dissolved solids were found due to the predominance of water from thermal and mineral springs.

As noted above, surface water in San Antonio Creek, Vallecitos Creek, Fenton Lake, Rio de las Vacas, and Rio Guadalupe have low concentrations of dissolved solids. Similarly low concentrations are found in portions of the Jemez River and Sulphur Creek that are not affected by mineral-rich springs. Table 3-2 from Miera et al. (1984, 24-0014) permits a comparison of trace element concentrations in water from the holding ponds with concentrations in surface and ground waters from natural sources in the vicinity of Fenton Hill. The mean values of settling pond concentrations of the five constituents (boron, arsenic, cadmium, lithium and fluoride) are generally greater than the upper bound of the values reported for surface water but, except for fluoride, are below the upper bound of the values reported for groundwater.

The HDR project, as expected, circulated large quantities of water. Some chemical constituents found in the water were the result of additives to the drilling mud used for the deep holes. Other constituents resulted from interaction of water with the hot rock during the experiments. Drilling fluids were contained in mud pits close to each hole, and no reports that the fluids overflowed the pits have been found.

Several ponds were used to contain the circulating water during the experiments. The ponds were required to handle variations in water needs during operations but could not hold the entire contents of the HDR circulation system. Therefore, when the circulation system was emptied at the end of an experiment, water was released from GTP-3, the downstream storage pond, into Burns Swale, a dry tributary of Lake Fork Canyon. The settling pond water was typically high in dissolved solids and high in arsenic, boron, cadmium, lithium, fluoride, and chloride relative to natural surface water, but below typical levels found in groundwater, as shown in Table 3-2.

TABLE 3-2

Trace Element Concentrations in HDR Effluents and Natural Waters

	Surface Waters mg/l	Ground Waters mg/l	Settling Ponds* mg/l
Boron	<0.1-1.2	0.2-11.0	6.8
Arsenic	<0.005-0.007	<0.005-0.924	0.23
Cadmium	<0.0005-0.001	<0.0005-0.0016	0.0007
Lithium	<0.03-1.16	<0.03-14.7	8.2
Fluoride	[illegible]2	1.27	4.10

*Values are mean concentrations for three holding ponds located at the HDR site.

Source: Miera et al. 1984, 24-0014, Table X

The settling pond concentrations in Table 3-2 are the averages of all measurements taken. As discussed in Section 5.2.1, these concentrations were highly variable depending upon experimental and climatic conditions, and sometimes exceeded release limits. Samples were taken to determine the quality of the settling pond water prior to releases, and releases were not made if the established water quality standards were exceeded. Additional discussion of the release practices and of exceptions to the release rule is presented in Section 5.2.1.

Kaufman and Siciliano (1979, 24-0013) state that the released water rapidly seeped into the alluvium in the swale and that the alluvium had a large capacity to sorb at least the fluorine from the infiltrating water. Natural levels of fluoride were reached within a few hundred feet downstream of the discharge point.

3.6 Conceptual Geologic/Hydrologic Model of Operable Unit

Laughlin (1981, 24-0031) presents a useful conceptual model for the hydrogeology of the Fenton Hill site that he attributes to Trainer (1974, 24-0035). Most important is the alluvial system of the Jemez River, Rio Guadalupe, and Rio Cebolla. The recent alluvium in the bottoms of these rivers and their tributaries is the most permeable unit in the area and is the source of most of the domestic and public water supplies in the area. These alluvial aquifers receive most of their water from the Valles caldera or high in the surrounding mountains.

Two other aquifers are important to the geohydrologic system. Perched aquifers in the Cenozoic volcanics, which are principally localized in low areas on top of the Abo Formation, supply some wells but more importantly discharge cold, high-quality water to springs along the steep canyon walls. The springs add to the base flow of the streams and rivers. The most significant well in the volcanics is the water supply well FH-1 for the Fenton Hill site.

The other source of base flow to the rivers and subsequent recharge of the alluvial aquifers is the deep circulation system principally in the Madera formation. This system is recharged principally from within the Valles caldera rim along faults and fractures that lead deep into the hot rocks near the magma source of the volcanic sequence. There is no source of water capable of significantly recharging the Madera at Fenton Hill. This regional aquifer system is most important in supplying the Jemez River, and less so for the Rio Guadalupe and Rio Cebolla. The water from this system is rich in dissolved salts and, in particular, several springs have relatively high concentrations of lithium, boron, fluorine, and arsenic.

At Fenton Hill, seepage from unlined surface ponds at TA-57 that may have infiltrated into the Cenozoic volcanics could percolate down through fractures to the aquitard at the top of the low- permeability Abo Formation. From there it could follow a buried channel to surface as a spring on the side of Lake Fork Mesa. Unless there are undiscovered fault zones at TA-57, surface effluent from TA-57 is not likely to reach the Madera Formation. Faults that might penetrate the Abo aquitard occur north and south of Fenton Hill, but none are known at the site.

Effluent that was within regulatory limits but contained elevated levels of arsenic, boron, and lithium was released from GTP-3 in the late 1970s and early 1980s. The releases were carefully monitored. Observations by Purtymun and co-workers defined the mechanism of flow and infiltration of the effluent and documented that little impact to the environment was observed. The effluent infiltrated into the dry stream bed of Burns Swale within 120 m (400 ft) of the Fenton Hill site fence. Little or no impact on groundwater in the dry alluvial channel was observed presumably because constituents sorbed onto the sediments in the channel. Bioaccumulation in trees along the channel was observed but fell to background levels soon after regular releases were terminated. This is further discussed in Section 5.2.1. It is unlikely that future releases from the site could lead to impacts as severe as those resulting from the regular releases during operations, because nothing exists today with contaminant concentrations as great as the pond brines present during operations.

The regional aquifer at the base of the Madera Formation occurs in a limestone that has cavernous-type permeability and was typically a lost circulation zone during drilling. The temperature of the water suggests that this formation is connected to, and possibly drains, the thermal water system in the caldera. This formation has some spring discharge to the Jemez River in the reach from Battleship Rock to Jemez Springs. The few points of Madera spring discharge are usually characterized by hydrogen sulfide and high dissolved solids including elevated levels of arsenic, boron, lithium, and flouride. Because of its poor quality, little use is made of the Madera water, except for hot spring bathing.

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Executive Summary

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4.0 TECHNICAL APPROACH

The overall objective of this work plan is the identification and, in some instances, the characterization of environmental contamination. For the purposes of this work plan, the term "environmental contamination" is defined as the contamination of natural materials or of manmade materials that have been abandoned to become part of the long-term environment. These materials can include air, water, soils and sediments as well as abandoned waste materials and facilities that are not currently planned to be removed and may be left in place indefinitely. Potentially contaminated facilities that are planned to be removed or are still actively used are addressed in this work plan only as sites to be deferred for characterization to a later time, unless a likely mechanism for significant accidental release to the environment has been identified.

This chapter describes the technical approach to RFI/CMS actions adopted for OU 1154. It provides the strategy and rationale for a phased approach to the RFI and describes how the guidance provided by the IWP (LANL 1993, 1017) was incorporated into this document. This chapter also provides details of technical aspects of the project, including the methods used to determine appropriate sampling techniques, analytical methods, and the number of samples required. A generalized conceptual exposure model and a discussion of potential remediation alternatives specific to the types of PRSs in OU 1154 are also provided.

Risk-based considerations in this work plan are limited to the comparison of sampling and analysis results to risk-based screening action levels (SALs) described in the IWP. The SALs are conservatively based on the theoretical exposure of a person residing at the site to various chemical and radiological substances that might be present in the environmental media sampled. Screening action levels based on residential exposure were chosen for Phase I data comparisons because the residential exposure scenario considers the most sensitive human population of any that could potentially occupy the site. Therefore, the SALs are based on the most stringent of any of the land use scenarios. In developing SALs, no consideration is given to exposure of humans under land use scenarios other than residential use, because SALs are used only as a screening tool. A preliminary evaluation of ecological risk will be conducted during the summer of 1994 using conservative models and available data. This evaluation may indicate that the risk is below acceptable limits, or it may indicate that additional data and/or a more sophisticated analysis will be required.

Based upon a detailed review of historic information, references, interviews, and discussion among the OU team members, PRSs in OU 1154 have been grouped by type of facility for investigation and remediation. A summary matrix listing the groups and the types of contaminants, affected media, and potential response actions is presented as Table 4-1. This information guided the preparation of the detailed sampling plans in Chapter 5. Details of the implementing process and some of the technical considerations that are the bases of the OU 1154 approach are presented in the following sections of this chapter.

4.1 Phased Approach

A phased approach has been adopted by the OU 1154 project team to meet the site assessment objective of the RFI process in an efficient and cost-effective manner. The phased approach uses available data, as they are obtained, to determine the requirements for further investigation, the adequacy of the data to support the decisions at hand, and the degree to which the data meet the needs of a particular stage of the investigation or corrective measures action.

The phased approach to site assessment used in this work plan is consistent with EPA (1987, 0821) and the Laboratory's IWP (LANL 1993, 1017) guidelines. A minimal Phase I field investigation is first used to confirm the presence or absence of contaminants of concern (COCs) that have been released to the environment. The potential COCs are identified from archival information that indicates the source of the waste materials, site visits during work plan preparation, and, when available, the analytical results of past sampling activities. A potential COC becomes a confirmed COC if that constituent is found in concentrations exceeding background and exceeding screening action levels as described in the IWP. If COCs are determined to be present based on the Phase I sampling results, the site is either recommended for a voluntary corrective action, further evaluated under a preliminary risk assessment, or is further sampled under a Phase II program. The Phase I Sampling and Analysis Plans (SAPs) are presented in Chapter 5 of this work plan. Any Phase II SAPs that may be needed will be developed based on the Phase I results and will be described in future reports.

TABLE 4-1

PRS Group Characteristics

Characteristic	PRS Group 1	2	3	4	5
Type of PRS					
Drilling Mud Pit	X				
Settling Pond		X			
Stream Channel		X			
Filtration System		X			
Sludge Pit			X		
Chemical Waste Storage Tank				X	
Leach Field				X	
Container Storage Unit					X
Potential Types of Contaminants					
Metals		X	X	X	
Petroleum Hydrocarbons		X	X		X
Solvents (VOCs & SVOCs)			X	X	X
Potentially Affected Media					
Surface Soils/Sediments		X	X		X
Subsurface Soils/Bedrock		X	X	X	
Air			X		
Structures				X	X
Potential Response Actions					
No Further Action (NFA)	X	X			X
Deferred Action (DA)		X			X
Voluntary Corrective Action (VCA)				X	
Phase I Sampling		X	X	X	
Potential Corrective Measures					
Removal Action		X	X	X	
Treatment		X	X		
Closure in Place		X	X		

Note: The PRS groups are identified in **Table 1-2.**

The logic for the phased approach adopted for OU 1154 is presented in Figure 4-1. Existing information is reviewed to develop an understanding of the processes and events that produced each PRS and any potential COCs. On the basis of existing information, four types of actions are being considered for OU 1154 PRSs. These four actions are described below.

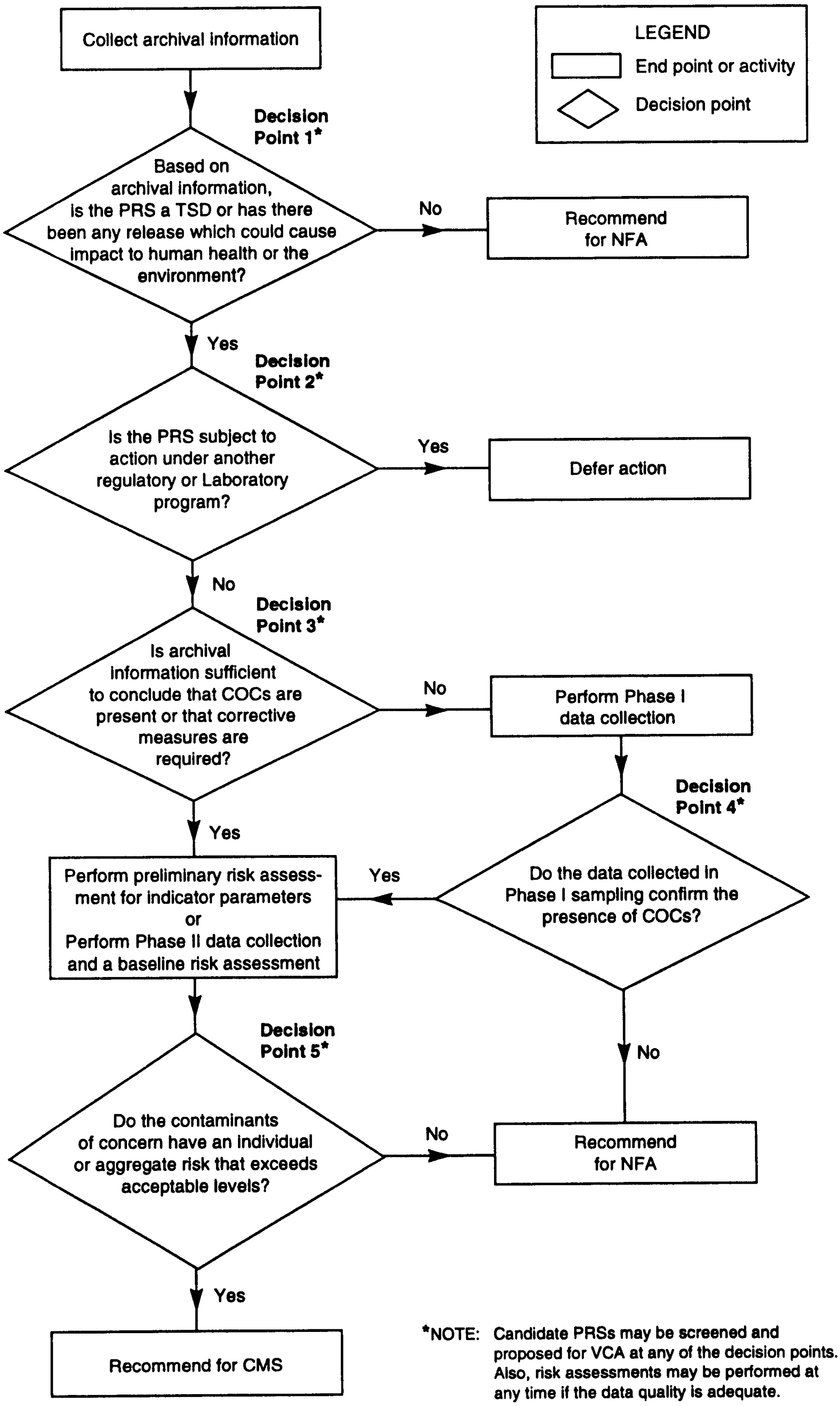


Figure 4-1. Decision process for OU 1154.

No Further Action (NFA). If, based on archival information, sampling and analysis results, or baseline risk assessment, the PRS is not now and will not in the future be a threat to human health or the environment, the site may be proposed for removal from further consideration by the ER Program. This finding can be made if the PRS meets one or more of four conditions (see Table 4-2) specified in the HSWA Module. This finding may be made as the first step in the RFI/CMS process based primarily on archival information. It may also be made at any step of the process when sufficient information becomes available to support the decision.

TABLE 4-2

NFA Criteria[1]

1. The site or PRS has never been used for the management (that is, generation, treatment, storage, or disposal) of RCRA hazardous constituents, radionuclides, or other CERCLA hazardous substances.
2. Site design, conditions, or institutional controls prohibit releases from the PRSs that would pose a threat to human health or the environment.
3. The PRS is part of a process operating under the Laboratory's current RCRA Part B permit, NPDES permit, or other applicable discharge permit. Potential environmental impact from these PRSs will be addressed by another program.
4. The PRS has been characterized or remediated in accordance with current applicable state or federal regulations, and the available data indicate that contaminants of concern are either not present or are present in concentrations near background levels.

1 These criteria are based on the conditions in Section J of the Laboratory's Hazardous Waste Permit (EPA 1990, 0306).

Deferred Action (DA). Deferred action is only possible if present conditions and associated risks are consistent with the current use of the site. Sites proposed for DA are generally in use or slated for D&D. If currently used for treatment or storage of hazardous materials, they are managed under the Laboratory's hazardous waste generator requirements or the Laboratory's DOE-based operational controls. If permitted, the active sites would be closed under the RCRA permit conditions. The Laboratory's D&D approach, on the other hand, consists of a flow of custody from the most recent Laboratory landlord to the Space Planning Group and then to the ER Program as a D&D project. The potential contamination associated with OU 1154 PRSs proposed for deferred action is associated with existing structures that are either part of facilities operating under the Laboratory's RCRA permit, are under DOE-based operational controls (currently active sites), or are slated for D&D. The current risk associated with these PRSs is small and is considered acceptable. The D&D activities and the RFI work described in this work plan will be closely coordinated.

Voluntary Corrective Action (VCA). A voluntary corrective action is initiated by the Laboratory if archival information, site observations, or sampling and analysis results indicate that immediate action is required, the corrective action is obvious and does not require study, or the action can be accomplished in an efficient and cost-effective manner. A VCA will involve cleanup or stabilization measures adequate to reduce risk to an acceptable level. The VCA may, however, consist of an interim action, such as stabilization, or a conditional remedy, that is not considered a final remedy. An interim action could include covering or removal of selected wastes, installation of a barrier fence or warning signs, or improving storm water management. An interim action will generally include plans for monitoring and implies that the PRS will eventually continue through the VCA process or the RFI process. The EPA may, usually based on new information, require the Laboratory to proceed with closure or other mitigation of a PRS in advance of the schedule set forth in the HSWA Module of the Laboratory's RCRA permit (EPA 1990, 0306). Interim actions required by the EPA are known as interim measures.

Phase I Sampling. For those PRSs not qualifying for NFA, DA, or VCA based on archival information, data are gathered during Phase I investigations primarily to identify whether a release has occurred and what COCs are present. It can also be used to identify those PRSs that may be recommended later for NFA, DA, or VCA, and those that may need further characterization by Phase II sampling. Phase I data may also be used to help identify any COCs present at the site and may be used for risk calculations.

Phase II Sampling. Phase II field investigations are conducted to characterize the nature and extent of contamination. Data collected at this stage must be of adequate quality to support the quantitative risk assessments that will be conducted for each PRS not subject to NFA, DA, or VCA. After a quantitative risk assessment is performed, a final decision for NFA, VCA, or corrective measures studies will be made.

The remainder of this section discusses decisions to be made as the phased approach is implemented. The decision points of Figure 4-1 and the information used at each point are discussed briefly. The sampling and analysis considerations introduced here as well as the treatment of uncertainty are subjects discussed in more detail in later sections.

4.1.1 Decision Point 1

On the basis of archival information, is the PRS a TSD or has there been any release that could cause impact to human health or the environment?

The function of Decision Point 1 is to differentiate, on the basis of available archival data and observation, between PRSs that clearly do not pose a potential risk to receptors and those that require further investigation. This decision must often be made on the basis of qualitative archival information and requires professional judgment on the part of the decision-makers.

Section J of the Laboratory's RCRA permit (EPA 1990, 0306) allows the Laboratory to submit an application for a permit modification at locations where existing information demonstrates that hazardous wastes, including hazardous constituents, that pose a threat to human health or the environment have not been released (and will not be released) from the PRSs. In those instances, no further action may be proposed. Any of four conditions, as specified in the permit, must be met for NFA. These four conditions are listed in Table 4-2. Although the OU 1154 site is not included in the HSWA Module, the same criteria were followed when implementing this work plan.

An affirmative decision at Decision Point 1 indicates that the PRS under consideration poses some degree of potential risk or that the available data are insufficient to deny the possible existence of risk. All such PRSs are recommended for further consideration at Decision Point 2. A negative decision indicates that, on the basis of professional judgment, the PRS poses no potential risk and should be recommended for NFA. Because of the judgmental nature of this decision, a recommendation of NFA cannot be made unless the available documentation and/or site inspections clearly show that at least one of the four NFA criteria is met.

Evaluation at Decision Point 1 divides the OU 1154 PRSs into two sets: one consisting of PRSs recommended for NFA and another set that will be evaluated at Decision Point 2. Because the first decision is made on the basis of existing archival information, all PRSs in OU 1154 were evaluated at Decision Point 1 during the preparation of this work plan. Potential release sites recommended for NFA at Decision Point 1 and the criteria used for the basis of such recommendations are presented in Chapter 6.

4.1.2 Decision Point 2

Is the PRS subject to action under another Laboratory or regulatory program?

At this point, selection and implementation of corrective measures may be postponed until a future date associated with RCRA closure or with D&D activities. It is assumed that the responsibility for cleanup rests with the program responsible for RCRA closure activities or will be accomplished as part of the D&D project. Although immediate action could be recommended at this time, no PRSs included in OU 1154 and found eligible for deferred action showed evidence of an unacceptable current risk, based on archival information and visual inspection. The rationale supporting this conclusion is presented with the discussions of the individual PRSs in Chapter 5.

4.1.3 Decision Point 3

Is the archival information sufficient to conclude that COCs are present or that corrective measures are required?

Decision Point 3 allows the set of PRSs requiring further characterization to be sorted for development of Phase I or Phase II SAPs. The purpose of this decision is to determine which PRSs need Phase I characterization before initiating a more detailed (and costly) Phase II investigation. Pre-existing analytical data will not be used at OU 1154 for comparisons to background, screening action level comparisons, or risk calculations. This is because archival data are of unverifiable quality and are therefore used only as information to support NFA, DA, or VCA recommendations or sampling plan design.

Archival data and information gathered in site visits during SAP preparation were used to help determine if Phase I or Phase II sampling is more appropriate. All OU 1154 PRSs under consideration at Decision Point 3 were recommended for Phase I sampling. No PRS under consideration after Decision Point 1 will be recommended for NFA without a minimum amount of characterization performed under the strict RCRA-based quality assurance (QA) requirements presented in Annex II of this work plan.

4.1.3.1 Phase I Sampling

Phase I sampling will be conducted at PRSs where contamination is suspected based on archival information. The goal of Phase I sampling is not complete characterization of the site but discovery of COCs. Information on site history, physical site characteristics, chemical and physical behavior of suspected constituents, and other factors are all considered in determining the appropriate locations and depths at which samples must be collected to confirm the presence or absence of COCs. With the exception of sampling results from the chemical waste storage drum in Group 3, no analytical data pertaining to OU 1154 were of sufficient quality to justify bypassing Phase I sampling for the purpose of comparing data to background levels, screening action levels, or for use in risk calculations. The storage drum was sampled in the summer of 1993, and the data were considered to be of sufficient quality to recommend a voluntary corrective action. This action will be performed independently of this work plan and is further discussed in Chapter 5.

Phase I sampling is performed for selected indicator constituents at locations that are highly likely to have been contaminated if a release to environmental media had occurred. These indicator constituents are generally a subset of the potential COCs that may be present and are selected on the basis of their quantity, toxicity, mobility, and/or ease of detection. In many instances, the laboratory analyses for the specified indicator constituents are expected to employ methodologies that will also yield information on many other related chemical constituents, such as other metals, volatile organics, or semivolatile organics as well as the indicator constituents. Even though not all constituents that could be detected by the methods are specified indicator constituents, the analytical laboratories will be instructed to provide data on anomalous quantities of any constituents that the methods detect.

4.1.3.2 Phase I Analytical Levels

Phase I samples will be analyzed to determine if a release has occurred that exceeds background levels as well as established SALs for the types of chemical and radiological constituents that are likely to have been present. If a significant release has occurred, these data will be supplemented as required during Phase II sampling with any additional information that is needed to conduct a risk assessment.

Phase I samples will be analyzed in a manner appropriate for defensibly determining the presence or absence of environmental contamination and for supporting defensible risk assessments. Field screening for organic vapors and radioactive materials will be performed to determine the degree of required worker protection and to provide an initial indication of contamination. Hand-held instruments will be used to screen materials as they are sampled. Standard EPA protocols, or the equivalent, will be used for the indicator constituents. This will include both level II and level III analytics and may include the use of field laboratories. The only radioactive materials used at the site were very short-lived radioactive tracers that would no longer be detectable. However, natural radioactive materials could have been brought to the surface through the circulating waters used in the fractured reservoir. These radioactive materials may have concentrated in the settling ponds and the sludge pit.

4.1.4 Decision Point 4

Do the data collected in Phase I sampling confirm the presence of COCs?

Decision Point 4 addresses confirming the presence or absence of COCs at the PRS following Phase I sampling. If the sampling confirms the presence of COCs—that is, that waste constituents are present at concentrations above both SALs and background levels—Phase II data collection or a preliminary baseline risk assessment may be performed. A preliminary risk assessment is a determination of risk based upon the analytical results obtained only from the Phase I indicator parameters. The purpose of this assessment is to determine whether the Phase I data alone indicate the presence of an unacceptable risk and the need for a CMS. Alternatively, the discovery of COCs could lead to consideration of a voluntary corrective action. If the sampling indicates the absence of COCs, the PRS is recommended for NFA. A recommendation of NFA is justified by a technically sound and QA-validated sampling effort that has confirmed the absence of COCs at the PRS.

A concentration is considered to be above SALs if either one or more screening action levels is exceeded by validated waste constituent concentrations at a site or if the cumulative effects of multiple constituents exceed acceptable limits as defined in Appendix J of the IWP (LANL 1993, 1017). Phase I data will first be compared with SALs. If SALs are not exceeded, the site may be recommended for NFA without further analysis. If SALs are exceeded, the data are then compared to background levels. If background levels are also exceeded, COCs are considered to be present and the site is recommended for either Phase II action or a VCA, as described above. If SALs are exceeded but background levels are not exceeded, COCs are not considered to be present and the site is recommended for NFA.

The purpose of Phase II sampling is to more completely identify the nature and extent of contamination at a site based upon the results obtained from the Phase I sampling. Phase II SAPs are expected to vary significantly for individual PRSs depending upon the amount and type of data available from archives and from Phase I sampling results. Information on background levels and sources of potential variation in the environmental measurement process will be included in the design of Phase II sampling plans. Any Phase II SAPs that may be required will be generated in future reports specific to this OU.

Phase II will likely be an iterative process for most sites. The available analytical data, starting with the validated Phase I sampling and analysis results, will be used for risk assessments, planning additional physical and chemical site characterization activities, and evaluating alternative corrective measures. Phase II sampling may include determination of local background, if necessary, to make defensible comparisons. Phase II data collection and analysis activities will cease when a sufficient data base is established to perform defensible assessments of risk and defensible evaluations of alternative corrective measures. We expect to find that sites with extensive existing data will not require full Phase II sampling. The Phase II data requirements will also be amended as necessary to accommodate future program guidance on human health and ecological risk assessment methods.

4.1.5 Decision Point 5

Do COCs have an individual or aggregate risk that exceeds acceptable levels?

Decision Point 5, the final step in the phased approach decision process, is an evaluation of the total set of validated data now available for each PRS. It is triggered at the point at which PRSs have undergone field investigations and will be recommended for VCA, CMS or NFA. Concentrations of individual COCs at each PRS will be compared to acceptable risk levels for the COC. The calculated aggregate risk from COCs at the PRS will be compared to acceptable aggregate risk levels, where aggregate risk is the cumulative risk due to impacts of more than one contaminant.

Risk assessment methodologies adopted by the Laboratory reflect the basic concepts of the proposed Subpart S to 40 CFR 264 and incorporate guidance issued by the EPA under CERCLA and the Superfund Amendments and Reauthorization Act (SARA). Calculation of risk as additive for sites with multiple contaminants is assumed.

A recommendation of NFA at this point in the decision process will be justified for a PRS if the risk is not found to exceed acceptable levels for either individual or aggregated constituents. If the risk is found to exceed acceptable levels, a CMS is required unless an immediate VCA can be implemented. That is, an obvious, simple, accepted, and effective corrective action is available and practicable.

4.2 Decision Process and Management of Uncertainty within OU 1154

Any decision made on the basis of archival data or data from sampled environmental media will inevitably involve some degree of uncertainty. The following discussion describes the measures taken to manage uncertainty at each decision point.

Each of the five diamonds in Figure 4-1 represents a point at which a decision will be made for each PRS under consideration. At each decision point, the OU 1154 team has established constraints on uncertainty to ensure simplicity in the decision-making process. Each question posed has only two possible answers: "yes" or "no." Each of the decision points depends upon environmental sampling or archival data and therefore requires management of the uncertainty associated with those data. All OU 1154 PRSs have been evaluated using the initial steps in the phased approach: collect archival data and determine eligibility for designation as NFA, DA, or Phase I sampling on the basis of that data. Management of uncertainty at Decision Points 1 through 5 is described below.

4.2.1 Management of Uncertainty at Decision Points 1 and 2

Uncertainty was managed at Decision Points 1 and 2 by assembling as much historical information as possible about the PRSs within OU 1154. The decision at these points depended on existing data that the OU 1154 team collected and judged to be relevant to one or more PRSs. In most cases, qualitative information about past practices and processes was considered reliable for decision-making. To gain a preliminary understanding of current conditions at OU 1154, the OU team assembled archival information from a variety of sources. Published accounts of Laboratory operations provided a framework for developing ideas about general operations at various PRSs. In addition, memoranda, files, Laboratory reports, and engineering drawings, including change orders and as-built drawings, were researched and analyzed. Current and retired employees contributed operational information in interviews with OU 1154 team members. These sources of information were used to provide an understanding of site activities and operations and to determine what (if any) chemical constituents may be present at a given PRS.

Historical quantitative data about chemical constituents are also useful, but in general must be regarded with caution. In most cases, it is not possible to make statements about the uncertainty associated with historical quantitative data. Therefore the OU 1154 team used these data conservatively. Whenever information was judged inadequate or data were suspect, the team elected to collect additional data. Any PRS at which the risk level was questionable based on historical information either moved on to Decision Point 3 or was assigned an immediate VCA. Otherwise, the PRS was assigned to the NFA or DA category at Decision Points 1 and 2.

4.2.2 Management of Uncertainty at Decision Point 3

Decision Point 3 entails a judgment about the quality and utility of historical data. Data must be satisfactory to confirm the presence or absence of contaminants. The team has taken a very conservative approach to using available data to ensure this result. If the data set in question is recent, of known quality, and unambiguous with respect to screening action levels, Phase I sampling will not be conducted. In practice, the OU 1154 PRSs that are being recommended for further action will be subjected to Phase I sampling except for the chemical waste storage drum, which was sampled in the summer of 1993.

4.2.3 Management of Uncertainty at Decision Point 4

Decision Point 4 involves the comparison of quantitative data collected during Phase I investigations with background and SALs to confirm the presence of COCs. The primary focus of OU 1154 Phase I investigations will be to collect sufficient data to determine whether COCs are present at a given PRS.

4.2.3.1 The Data Quality Objective (DQO) Process

The principal tool for managing uncertainty in Phase I data collection will be the DQO process. This is a technique that carefully defines the specific role to be played by data in Phase I decision-making and identifies the quality and quantity of data required to make the decision. As applied to OU 1154, the DQO process has the steps summarized below. The site specific details on the DQO process are provided in Chapter 5.

Summary of the Problem. A concise statement of the environmental problem potentially associated with a given PRS or group of PRSs, including any existing data relevant to the problem.

Decision(s) To Be Addressed. A statement of the specific decision(s) to be made in order to resolve the problem. A typical decision for the OU 1154 Phase I investigation will be to proceed to Phase II if contamination at a given PRS is found to exceed established SALs and background levels.

Inputs. A description of the type(s) of environmental data that will be required to make the decision, including a specific list of constituents to be investigated.

Boundaries. A description of the spatial (and, if appropriate, temporal) boundaries that define the area from which samples will be taken and to which the decision will apply. For Phase I, this may be a segment of a PRS, an entire PRS, or a group of PRSs.

Decision Logic. A statement that builds on the preceding steps to rigorously define the decision to be made with data, the way in which data will be used to make the decision, and what actions will follow as a consequence of the decision. A typical Phase I decision rule will involve comparison of the maximum measured concentrations of a given set of indicator constituents to the SALs and background levels for those constituents.

Design Criteria. A qualitative or quantitative statement of what will be done to assure that the decision can be made with an acceptable degree of uncertainty. For the typical Phase I decision, an important criterion will be to employ judgmental sampling, that is, to locate sampling points in areas most likely to be contaminated. In some cases, visual evidence or historical process knowledge will make it possible to rely only on judgmental sampling as a design criterion (i.e., to specify a given number of judgmental sampling points as an adequate basis for the Phase I decision).

While the design criteria provided in this work plan place limits on acceptable uncertainty, they do so primarily by specifying an acceptable number of sampling locations. While it is recognized that this approach does not incorporate statistical sampling designs whose performance can be fully quantified, the approach does provide adequate planning specifications for the typical Phase I decision. It is anticipated that Phase II sampling designs may require a more rigorous statistical basis.

The outputs of the DQO process, described above, lead to definition of DQOs, including, but not limited to, specifications of the media and areas to be sampled, sampling protocols to be used, variables to be measured, analytical methods to be used, and precision and accuracy requirements for the sampling and analysis procedures. These specifications are the foundation for the Phase I sampling and analysis plans.

4.2.3.2 Statistical Sampling Approach

Uncertainty can also be managed during Phase I by employing a statistical approach to reconnaissance sampling. This approach directly links the number of samples to be taken in a given area to the importance of detecting contamination over a defined fraction of that area. This approach is described in Section 4.1 of Appendix H of the IWP (LANL 1993, 1017). However, statistically based techniques are commonly used to guide sampling designs at PRSs where locations of potentially contaminated sites are uncertain. Because the locations of the sites to be sampled at OU 1154 are known, statistical sampling approaches were not used for Phase I sampling designs in this work plan.

4.2.4 Management of Uncertainty at Decision Point 5

Decision Point 5 will depend on Phase II sampling to establish the nature and extent of contamination at a given PRS. Phase II sampling will provide the basis for performing a baseline risk assessment to establish the need for cleanup or other corrective measures and to determine appropriate cleanup levels. Phase II sampling will also be based on application of the DQO process. Because the decision to be made will be different from that at Decision Point 4, the DQO outputs will also differ. The steps of the process will, however, remain the same.

4.3 Assessment Considerations

Data quality requirements for field and analytical data collected at OU 1154 are governed by the need to make defensible, risk-based decisions for each PRS. The information collected will be based on sound professional judgment, required EPA protocols, statistical requirements, and overall data objectives for the project. This section presents information on sampling and analysis methods to be used for the OU 1154 RFI.

4.3.1 Sampling Actions

A variety of actions will be taken during the RFI sampling for OU 1154. Because it is not known whether environmental contamination has occurred at any of the PRSs planned to be sampled, the objective of the sampling is to determine whether a release has occurred that exceeds established SALs for the types of chemical constituents that are likely to have been present.

The sampling proposed for OU 1154 includes both surface and subsurface soils, sediments, and sludges. Surface samples will be taken by hand methods, and subsurface samples will be taken using drilling techniques. A summary of drilling activities is presented in Table 4-3.

TABLE 4-3

Summary of Drilling Activity for PRSs with Borehole Sampling

PRS	Number of Boreholes	Expected Borehole Depth (ft)	Total Expected Borehole Footage (ft)
Group 2	2	22	
Pond Sampling	1	30	30
Group 3	1	18	18
Pit Sampling	1	30	30
Totals	5		122

Numerous field activities have an impact on the overall quality of an ER Program. The sample collection activities that have a direct effect on data quality include equipment calibration schedules and procedures, sample method selection and techniques, sample containers, preservatives, sample holding times, the number or type of quality control (QC) samples, sample documentation, and equipment decontamination. To ensure that data quality is maintained in the field, specific details for each of these activities are documented in the SOPs listed in Annex II, the QAPjP for this work plan, and in the Laboratory Standard Operating Procedures Manual for the ER Program (LANL 1991, 0411).

4.3.2 Analytical Methods and Levels

The analytical methods to be used in support of this work plan are identified in the QAPjP in Annex II. These methods are considered preliminary, pending adoption of screening action levels for indicator constituents and adherence to contractual agreements by the analytical laboratories. The final analytical methods must be capable of achieving routine detection limits below the screening action levels and must be within the capability of the analytical laboratory. The sample volume and container specifications will also depend upon the laboratory's capabilities and requirements and may be different from the specifications presented in this work plan. The determination of analytical methods and levels for field and laboratory tasks will help to standardize analytical procedures for the project.

The analytical levels used for OU 1154 are as follows:

> **Level I Field Screening.** Photo ionization detector (PID), flame ionization detector (FID) instruments, or equivalent, will be used to screen soils, sediments, and sludges for organic vapors; a GM detector or ion chamber will be used to screen soils for gross beta and gamma contamination; an alpha scintillation detector, or equivalent, will be used to screen soils for gross alpha contamination.
>
> **Level II Field Analysis.** A field x-ray fluorescence (XRF) unit will be used to analyze soil, sediment, and sludge samples for metals.
>
> **Level III Standard Laboratory Analysis.** EPA SW-846 laboratory methods (EPA 1987, 0518), or equivalent, will be used on soil, sediment, and sludge samples for routine analytes. A mobile laboratory utilizing SW-846, or equivalent, methods may be utilized if available and if able to produce data of the required quality.

In general, Levels I and II are associated with on-site portable field instrumentation or tests that may be semi-quantitative or quantitative. Field portable radiation detection equipment is semi-quantitative, indicating level of contamination in counts per minute (cpm), but does not normally yield quantified concentration levels. Some portable instruments for detection of organics can yield semi-quantitative concentration information. Field XRF units are capable of yielding quantitative information on many metals. Level III analyses are associated with standard laboratory protocols and documentation that will generate high-quality, defensible data. These analyses may be conducted in field laboratories to similar levels of precision and accuracy. Organic analyses are expected to be performed using standard techniques that include use of gas chromatography. Inorganic analyses are expected to be conducted using standard inductively coupled plasma emission and atomic absorption spectrometric techniques.

4.3.3 Extended Analyte List

The OU 1154 extended analyte list (EAL) is presented in Table 4-4. The EAL identifies standard groups of metals and organic compounds for which analyses will be repeatedly performed at several PRSs. These constituents were selected because, if present, they would provide an indication of a release. They are based upon historical information, including the results of chemical analyses of process water, sludges, and drilling mud, information from Material Safety Data Sheets (MSDSs) for the additives used in drilling and other site processes, and information on site work practices and processes. Laboratory analyses will be performed for potentially hazardous metals that may have been present in the process wastewater, and field analyses will be performed by XRF on an abbreviated list of metals because of the limitations of the method. Lithium is not considered toxic to humans but is included for later use in evaluating environmental risk. The list of VOCs includes all compounds normally targeted in an EPA Method 8240 scan and likely to be present at the site (EPA 1987, 0518). The list of SVOCs includes compounds that may have been present in the drilling fluid additives.

4.3.4 Screening Action Levels

Screening action levels for contaminants of concern are presented in Appendix J of the Laboratory's IWP (LANL 1993, 1017) and are summarized for the indicator constituents in the QAPjP (Annex II of this document). These screening action levels will help determine whether a PRS contains COCs and whether to recommend for no further action, consider a voluntary corrective action, or to perform Phase II sampling.

The screening action levels are based upon a residential exposure scenario that is very conservative compared to other exposure scenarios. Because of this conservatism, chemical constituent concentrations below the screening action levels are unlikely to be of concern from the perspective of human health, regardless of future land use. The lowest SAL for each constituent, representing systemic or carcinogenic action, will be used (LANL 1993, 1017).

TABLE 4-4
Extended Analyte List

Metals for Laboratory Analysis		
Antimony	Arsenic	Barium
Beryllium	Cadmium	Chromium
Cobalt	Copper	Lead
Lithium	Mercury	Nickel
Selenium	Silver	Thallium
Uranium	Vanadium	Zinc
Metals for Field XRF Analysis		
Barium	Cadmium	Arsenic
Chromium	Copper	Cobalt
Mercury	Lead	Selenium
Silver	Nickel	Uranium
Zinc	Thallium	
Volatile Compounds		
Acetone	Acetonitrile	Benzene
Bromoform	Carbon disulfide	Carbon tetrachloride
Chloroform	2-Hexanone	Isobutyl alcohol
Methylene chloride	Methyl ethyl ketone	4-Methyl-2-pentanone
Pyridine	Tetrachloroethene	Toluene
Trichloroethene	Tricholorofluoromethane	Vinyl acetate
Vinyl chloride	Xylenes (total)	
Semivolatile Compounds		
Acetophenone	Anthracene	Benzyl alcohol
o-Cresol	m-Cresol	p-Cresol
Dibenzofuran	Diethyl phthalate	2,4-Dimethylphenol
Dimethyl phthalate	2,4-Dinitrotoluene	4,6-Dinitro-0-cresol
2,4-Dinitrophenol	Naphthalene	Di-n-octyl phthalate
Fluroanthene	0-Nitroaniline	1-Naphthylamine
2-Naphthylamine	Nitrobenzene	m-Nitroaniline
p-Nitroaniline	Phenol	o-Nitrophenol
p-Nitrophenol		p-Phenylenediamine

The SALs presented in the OU 1154 QAPjP are those currently in effect; however, contaminant levels of concern are periodically reviewed by EPA as additional data become available, and the screening action levels in effect at the time of sampling will be used in analyzing the Phase I data obtained under this work plan.

The methods for determining the screening action levels are based upon EPA guidance and are described in Appendix J of the IWP (LANL 1993, 1017). If a Laboratory screening action level is not available for a constituent at the time of Phase I sampling, an alternative screening action level will be developed based upon available defensible toxicological data or upon such considerations as comparison with background, regulatory limits, and the practical quantification limit for the constituent.

4.3.5 Required Quantification Limits

As a general rule, the required quantification limits for laboratory analyses will be the practical quantification limits (PQLs) for the analytical methods as applied to OU 1154 soils. On a case-by-case basis, limits higher than PQLs can be allowed if they will produce data acceptable for site decisions. The analytical methods and PQLs for the selected indicator constituents are given in the QAPjP in Annex II. The methods were drawn from standard EPA sources (EPA 1987, 0518). Practical quantification limits are media-specific, and those that have not yet been identified for OU 1154 soils will be determined as part of the Phase I sampling effort. Alternative analytical methods will be sought if the PQL is determined to be greater than the screening action level in effect at the time of sampling.

4.3.6 Quality Assurance Sampling

Quality assurance sampling consists of the collection of (1) duplicate samples of environmental media to monitor the consistency in analytical extraction methodology, (2) equipment rinsate samples to monitor the efficiency and thoroughness of the field decontamination procedures, and (3) field blanks to monitor the sample preparation and handling processes.

Collection protocols for these and other quality assurance samples are described in LANL ER Standard Operating Procedure (SOP) 1.05 (LANL 1991, 0411). The SOP does not contain guidance on selection of the appropriate locations for collection of quality assurance samples.

Duplicate samples are two samples taken from the same sampling location and represent the same sampled material. Duplicate samples best serve the intended purpose if those samples are collected at locations containing a range of concentrations of one or more potential contaminants of concern. The usefulness of duplicate samples is substantially reduced if collected only at sample locations that contain no potential contaminants of concern. The selection of an appropriate field location for duplicate sampling should be biased toward those areas that have visible staining or areas that exhibit detectable concentrations on direct-reading monitoring instruments. To maximize the chance of obtaining a useful duplicate sample, decisions regarding sampling locations for the duplicate samples will be made by the field sampling team after they have completed any surveys with direct-reading instruments.

Equipment rinsate samples should be collected after sampling equipment has been used in likely contaminated areas; there is little utility in collecting equipment rinsate samples from "clean" areas. The decision regarding which equipment rinsate sample to collect as the rinsate sample representing the sample batch is made by the field sampling team. Rinsate samples are not required if disposable sampling equipment is used.

Field blank samples should also be prepared at locations that are potentially contaminated. The purpose of a field blank is to monitor the possible introduction of spurious constituents during the sample preparation and handling processes and is best served by preparing the sample in areas where contaminants not present in the sampled medium may be entrained during preparation and handling.

4.3.7 Record Keeping and Field Logs

All records generated by OU 1154 field investigations will be processed and archived in accordance with the Records Management Plan presented in Annex IV of the IWP (LANL 1993, 1017). Records generated during field activities will be documented in the field log. Records documenting activities occurring after samples are shipped from the field to the analytical laboratory, including laboratory analyses, laboratory analytical results, data validation, data analysis, and preparation of the RFI Report, will be archived in accordance with the Records Management Plan.

A field log will be maintained during the sampling program. The log will document pertinent field activities, including the sampling activity, record the information obtained from the field screening instrumentation, identify the procedures used in sampling and sample site selection, identify the personnel involved, and record any other information pertinent to the sampling process and to the quality of the results. Field logs maintained by individual field team members will be consolidated into a master log at the end of each major sampling activity.

The completed field log will document the implementation of this work plan. Most importantly, it will document the site-specific decisions of the Field Team Leader required under the phased approach presented in this plan as well as any modifications to the plan required to address unanticipated site conditions. Because sampling and site characterization are essentially processes of discovery, minor modifications to the sampling plan and to its implementing procedures may occur. As a vehicle for documentation, the field log will be written to provide sufficiently comprehensive descriptions of the sampling activities and their rationale so that modifications to the work plan are not expected to be needed.

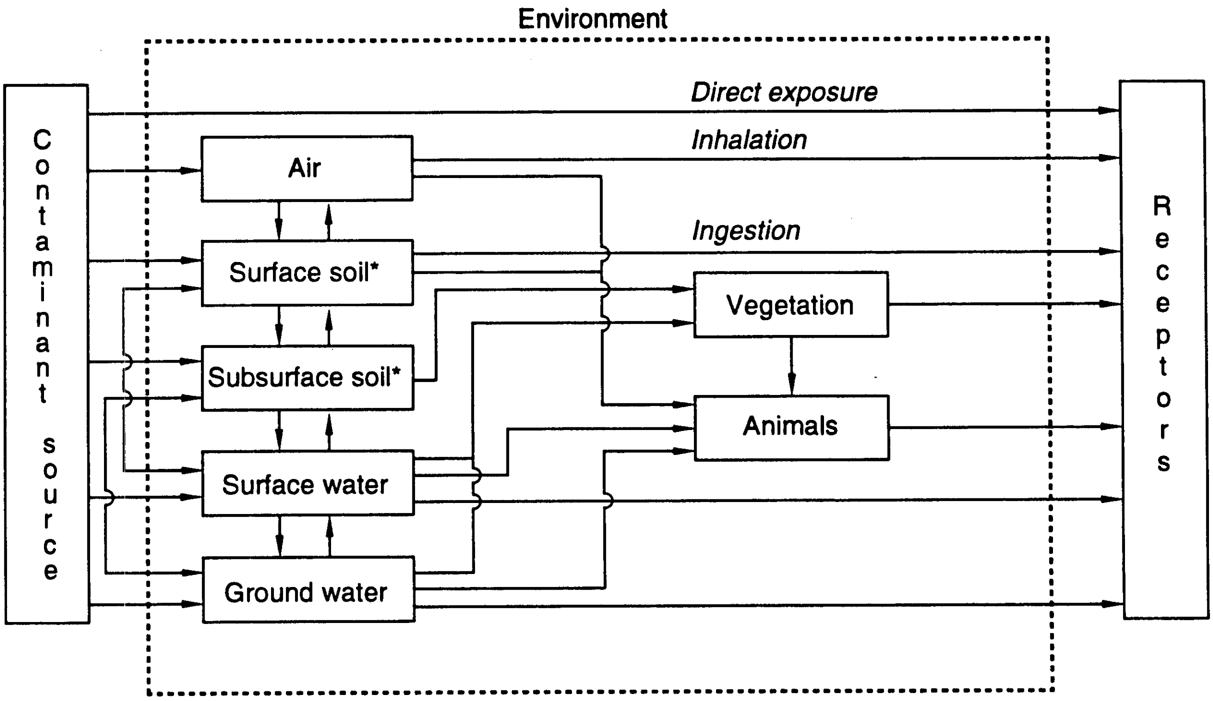
4.4 Conceptual Exposure Model

The ER Program's RFI process is based on reducing the risk to human health and the environment to acceptable levels. The technical approach to reducing those risks to acceptable levels for OU 1154 is based on risk analysis. This requires the estimation of acceptable risks based on knowledge of present use and assumed reasonable scenarios of future use.

4.4.1 Potential Transport Processes

A review of historical information on past operations at the various PRSs within OU 1154 and an evaluation of the likely chemical transport processes indicate that affected environmental media consist of surface (0 to 2 ft) and subsurface (greater than 2 ft in depth) soil, sediments, and sludges resulting from process operations. None of the PRSs are associated with releases or direct discharges to natural water bodies, so contaminants that might be present at a PRS should be confined primarily to the soil medium or retained in the sludges.

Chemical substances released on the ground surface may be transported through several mechanisms. Substances with the potential to volatilize will transfer from the soil surface directly into the air. Nonvolatile but water-soluble substances will dissolve into water from rain or snow melt moving across the soil surface or infiltrate into the subsurface. Water-insoluble and nonvolatile substances will adsorb to soil particles, and movement of such substances is largely constrained by movement of the host soil particles. Erosion of the surface soil and sludges through the action of wind and water is the primary mechanism for movement of such substances. The conceptual exposure model is presented in Figure 4-2.



*Subsurface soil may be brought to the surface by the action of burrowing animals or exhumation by man.

Figure 4-2. OU 1154 conceptual exposure model.

If chemical contamination is present from direct release to subsurface soil, such as through the bottom of a pond that was later backfilled, the possible transport scenarios consist of:

- no movement beyond the point of release, particularly when nonvolatile water-insoluble constituents are considered;
- movement to the surface through evapotranspiration or, when volatile chemical substances are present, through vapor emission from the soil;
- movement to the surface through excavation activities of man or through activities of burrowing animals;
- downward movement with percolating water through the soil; and
- downward movement with percolating water to perched groundwater, with subsequent lateral movement with the perched water.

Contamination of groundwater is not considered in Phase I investigations because the depth to perched water is on the order of 450 ft, and the depth to the water table aquifer is about 1750 ft. Because of the magnitude of these depths and the low permeability of the bedrock, movement of contaminants to groundwater is unlikely. Groundwater will be investigated if Phase I sampling results indicate a potential for contamination.

Storm water run-off from OU 1154 flows both to the south into Lake Fork Canyon and to the north into an unnamed canyon. However, the site is relatively flat, and the surrounding area is well vegetated; therefore, it is unlikely that soil carried by movement of surface water from PRSs at OU 1154 has been deposited within the canyons.

4.4.2 Affected Environmental Media

At OU 1154, the environmental media subject to investigation under Phase I include soils, sediments, and waste sludges. The various environmental media that could become contaminated are limited in number but are important to exposure scenarios pertinent to a wide variety of receptors.

The presence of chemical constituents in surface and subsurface soils may be considered in evaluations of risk, whether they are human-oriented or ecologically oriented. Human exposure to soils, regardless of the type of receptor (such as residential, worker, recreational, or agricultural users of the land), may occur through ingestion, dermal contact, and inhalation of soil in the form of dust. Additional exposure pathways may occur to residential and agricultural users through use of the land to grow food for direct consumption or for indirect consumption (such as through growth of animal feed and subsequent consumption of the animals). Although dust exposure occurs by way of air, the source of contaminated dust is most likely to be the soil. Also, there is a potential of exposure to chemical vapors that might be emanating from the soil. Vapor exposure of relevance to the ER Program largely occurs as a result of contaminated soil, even though the exposure is occurring by way of the air. Therefore, characterization of the soil medium at each PRS under investigation is important to the evaluation of risk potential of virtually any future human receptor.

Characterization of soil as a contaminated environmental medium is equally important in ecological risk assessments. Virtually any plant and animal exposure model will include exposure to soil. To illustrate, exposure to terrestrial animals may occur as a result of ingestion of plants that grow in contaminated soil. The plants take up, through the roots, many of the contaminants that might occur in soil or become contaminated because contaminated dust settles on the plant surfaces. Also, many animals incidentally ingest soil as a part of their diet (such as burrowing animals and animals that pull the entire plant from the soil when grazing), have dermal contact with contaminated soil, and breathe in contaminated dust and vapors in the same manner as humans. Therefore, soil sample data gathered during Phase I investigations have utility in evaluating potential impact to plants or animals, regardless of what approach may be developed by the Laboratory for assessing ecological risk.

4.5 Remediation Alternatives and Evaluation Criteria

Remediation alternatives and evaluation criteria for each type of PRS involve a variety of considerations. While there are a range of possible response actions, the remediation alternative at a particular site depends on the affected media, the types of constituents, and the nature and extent of contamination. If the data obtained in Phase I and Phase II and the risk assessment indicate remediation of a PRS is necessaary, a CMS is performed. Subsequent to the CMS, an appropriate corrective action is selected.

Specific criteria are used in the evaluation process, and these criteria determine the data required for each PRS.

4.5.1 Affected Media

A preliminary evaluation of remediation alternatives requires identifying the media that may have become contaminated at the various units under consideration. The results of evaluating PRSs and associated affected media are shown in Table 4-1. It should be noted that for the purpose of corrective action, the affected media are somewhat more broadly defined than for environmental media (Section 4.4.2).

4.5.2 Types of Response Actions

Generally, as the IWP points out in Section 4.5 (LANL 1993, 1017), the RCRA process can terminate at a number of points. The end points include NFA, DA, VCA, and final remediation through implementation of corrective measures. Corrective measures study and corrective measures implementation (CMS/CMI) follow the RFI if none of the above actions lead to termination or postponement of the RCRA process. If a PRS is found to have COCs present above levels considered protective of human health and the environment, as determined by baseline risk assessment, a CMS will be undertaken to compare optional remedies against criteria specified in the HSWA Module of the Laboratory's RCRA permit (EPA 1990, 0306). The IWP summarizes corrective measures under four categories: containment technologies, removal technologies, treatment technologies, and disposal technologies. The corrective measures may be conducted on- or off-site.

4.5.3 Types of Corrective Measures

Removal actions: Under this corrective measure, all or part of the waste would be removed. Depending upon the type of contaminated media, removal technologies can consist of excavating earth materials, dredging sediments, and pumping liquids and sludges. While these removal technologies are standard practices, their application to the removal of hazardous waste requires special technical considerations. Extensive safety and monitoring procedures, special adaptive equipment, significant amounts of hand work, and the selective removal and segregation of incompatible wastes may be required.

Treatment: Some wastes may require treatment prior to disposal. These treatment technologies are designed to change the physical, chemical, or biological character or composition of a hazardous waste, so as to render it nonhazardous or less hazardous, or to make it amenable for volume reduction. The nature of the treated waste material would determine whether ultimate disposal would be on- or off-site. The treated wastes must also meet land disposal restrictions; otherwise, a variance will have to be secured. Waste treatment can take place off-site at a separate facility or on-site; however, few hazardous waste treatment facilities currently exist at the Laboratory. For example, incineration is a treatment technology for waste streams containing organics; currently these wastes would have to be incinerated at an off-site facility prior to disposal.

Whereas on-site treatment technologies have extensive applications in closures of hazardous waste sites, available treatment processes or techniques that are either located at off-site facilities or that could be implemented *in situ* include solidification, physical stabilization, chemical fixation, encapsulation, bioremediation, soil flushing/washing, soil vapor extraction, reverse osmosis, ion exchange, and vitrification. However, *in situ* treatment applications for many disposal areas will be limited because of the heterogeneous nature of the waste type and forms.

Closure in place: Certain types of PRSs, such as the ponds and sludge pit, could be suitable for closure in place. The main element of this option includes a low-permeability barrier (or cap) designed to prevent direct contact with receptors; control run-on and run-off and the infiltration of surface water and precipitation; control the release of soil vapors; and prevent wind-blown transport of dust. Various cap designs and materials are available, including compacted local soil and topsoil caps, asphalt or Portland cement concrete caps, and multi-layered caps consisting of a low-permeability layer, a drainage layer, and topsoil. In addition, these engineered caps help prevent erosion and plant and animal intrusion. Other elements of closure in place may include subsurface drains when shallow groundwater is present, storm water management (e.g., grading, terracing, ditches, channels, berms, dikes, and floodwalls), groundwater controls, and post-closure monitoring and maintenance.

4.5.4 Evaluation Criteria

The Laboratory's RCRA permit (EPA 1990, 0306) specifies the criteria that will be considered in evaluating, recommending, and selecting a corrective action. Chapter 4 of the IWP (LANL 1993, 1017) further describes the criteria that will be considered at each stage of the evaluation process. In an early, focused mode, these criteria can be simplified to the elements listed below.

Technical Concerns. Each corrective measure shall be evaluated based on the technical criteria of performance, reliability, implementability, and safety. Performance is based on the effectiveness and useful life of the measure. Corrective measure reliability includes operation and maintenance requirements and is a way of measuring the risk and effect of a failure. Implementability of each corrective measure assesses the constructibility and the total time required to achieve a given level of response. The safety evaluation includes threats to the safety of nearby communities and environments as well as to workers during corrective measure implementation.

Environmental Concerns. Environmental assessment for each corrective measure alternative focuses on facility conditions and pathways of contamination. At a minimum, this evaluation consists of short- and long-term beneficial and adverse effects, adverse effects on environmentally sensitive areas, and analysis of measures to mitigate adverse impacts.

Human Health Concerns. The human health assessment describes the levels and characterizations of contaminants on-site, potential exposure routes, and potentially affected populations. This assessment also evaluates each corrective measure alternative in terms of the extent to which it mitigates short- and long-term exposure to any residual contamination and protects human health.

Institutional Concerns. Institutional needs for each corrective measure alternative are evaluated in terms of other environmental and public health standards, regulations, and guidance for the design, operation, and timing of each alternative.

Cost Concerns. A cost estimate will be prepared for each corrective measure alternative. This estimate shall include capital costs and operation and maintenance costs.

4.5.5 Data Requirements for Remediation

Based on the evaluation criteria, data should be collected about PRS conditions that affect the evaluation and recommendation of remedial alternatives. Field investigation activities consist of measurements, sample collection, and sample analysis that are designed to obtain site data to characterize environmental conditions and contaminant concentrations and distributions in suspect media. These data are then used to support the selection or revision of remedial alternatives.

At later stages of the corrective action process (post Phase I and II sampling), additional site characterization data may be needed to support or evaluate a remedial alternative. Because soil and rock are the likely suspect contaminated media for many PRSs, some investigations may require quantitative measurements of the geotechnical and/or geochemical properties of soil or rock. Identification of properties such as grain size, bulk density, porosity, permeability, cation exchange capacity, or total organic carbon may be needed to complete remedial alternative evaluation. Other site characterization data that could be required are site-specific testing data from innovative technologies.

References

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Executive Summary

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Background Information for Operable Unit 1154

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Chapter 4
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Chapter 5
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Chapter 6
Recommendations for No Further Action

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Chapter 5

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- Group 2—Settling Pond System
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- Group 4—Chemical Waste Disposal Areas
- Group 5—Container Storage Facility

5.0 POTENTIAL RELEASE SITES

Chapter 5 presents descriptions and sampling plans for the PRSs in OU 1154 that have been recommended for Phase I sampling, deferred action, or voluntary corrective action. The PRSs that have been recommended for no further action are listed in Chapter 5, but reference is made to Chapter 6 for complete descriptions. Chapter 5 has been divided into sections that correspond to the five groups of PRSs that comprise OU 1154. In each section, the PRS(s) in the group are described, the remediation decisions and investigation objectives are presented, the data needs and DQOs are identified, and the sampling and analysis plans are given.

The PRS groups consist of PRSs that are functionally and physically similar. Each group consists of one or more PRSs. The groups presented are: Group 1, the drilling mud pits; Group 2, the settling pond system; Group 3, the sludge pit; Group 4, the waste disposal areas associated with the chemistry trailer; and Group 5, the container storage facility. The locations of the groups are shown in Figures 5-1 and 5-2. The actions to be taken at the five groups are summarized below in Table 5-1. It may be noted that more than one type of action may be taken at a single PRS.

All samples will be field screened for volatile organics and radioactive constituents as a safety measure. Volatile and semivolatile organics may be encountered at several sampling sites and are included as indicator parameters for laboratory analysis. Although elevated levels of radioactivity are not expected at any OU 1154 PRSs, samples will be field screened for raadioactive constituents because of the ntaural uranium that was dissolved from the bedrock by the geothermal circulation fluids. If elevated radiation levels are found, the associated samples will be analyzed for gross alpha and beta in additioin to the indicator parameters specified in this chapter.

5.1 GROUP 1: DRILLING MUD PITS

The drilling mud pits [PRS 57-001(a)] were found to contain no hazardous constituents and are being recommended for no further action. They are discussed in Chapter 6.

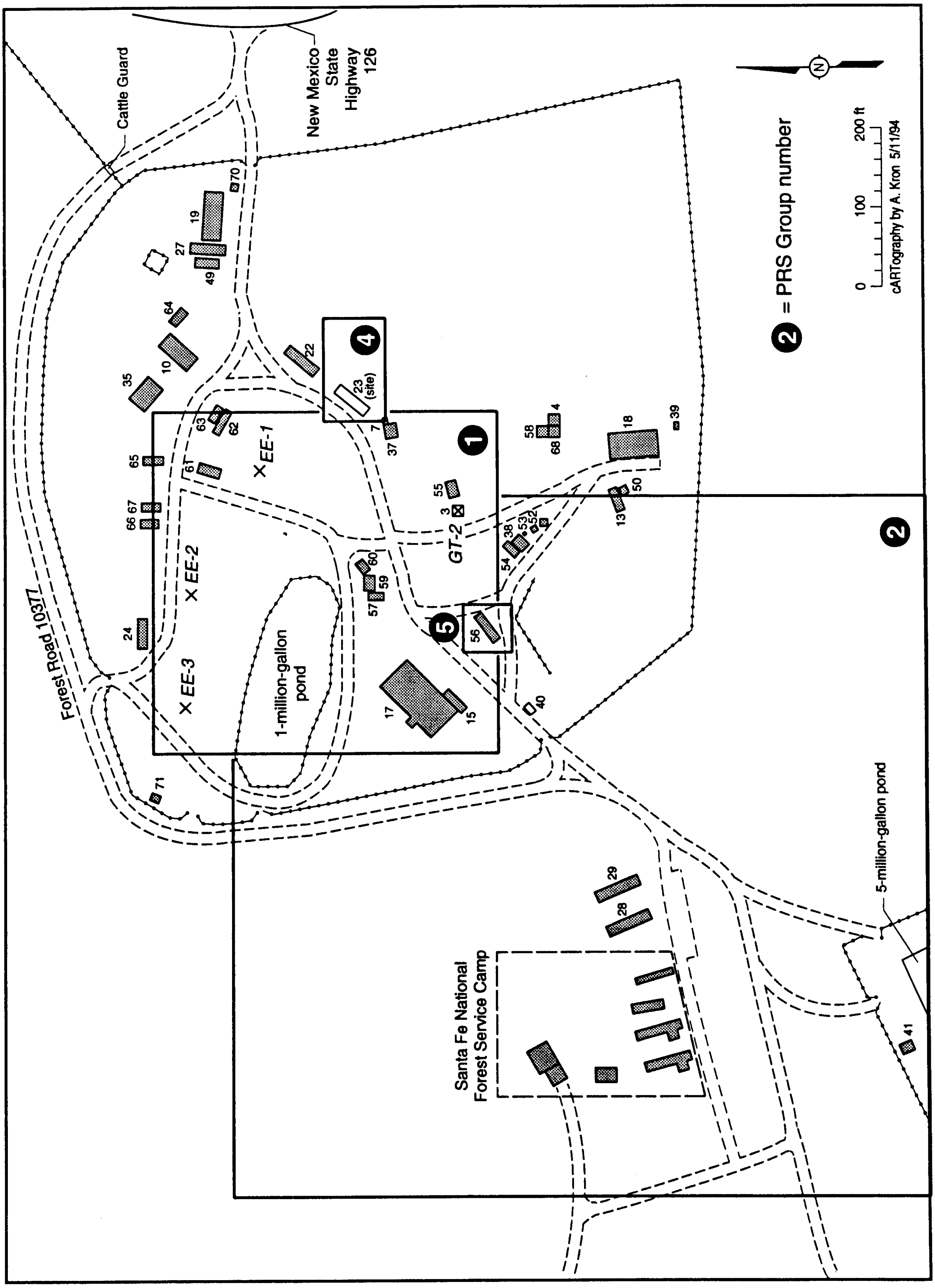


Figure 5-1. Locations of PRS groups at Fenton Hill compound.

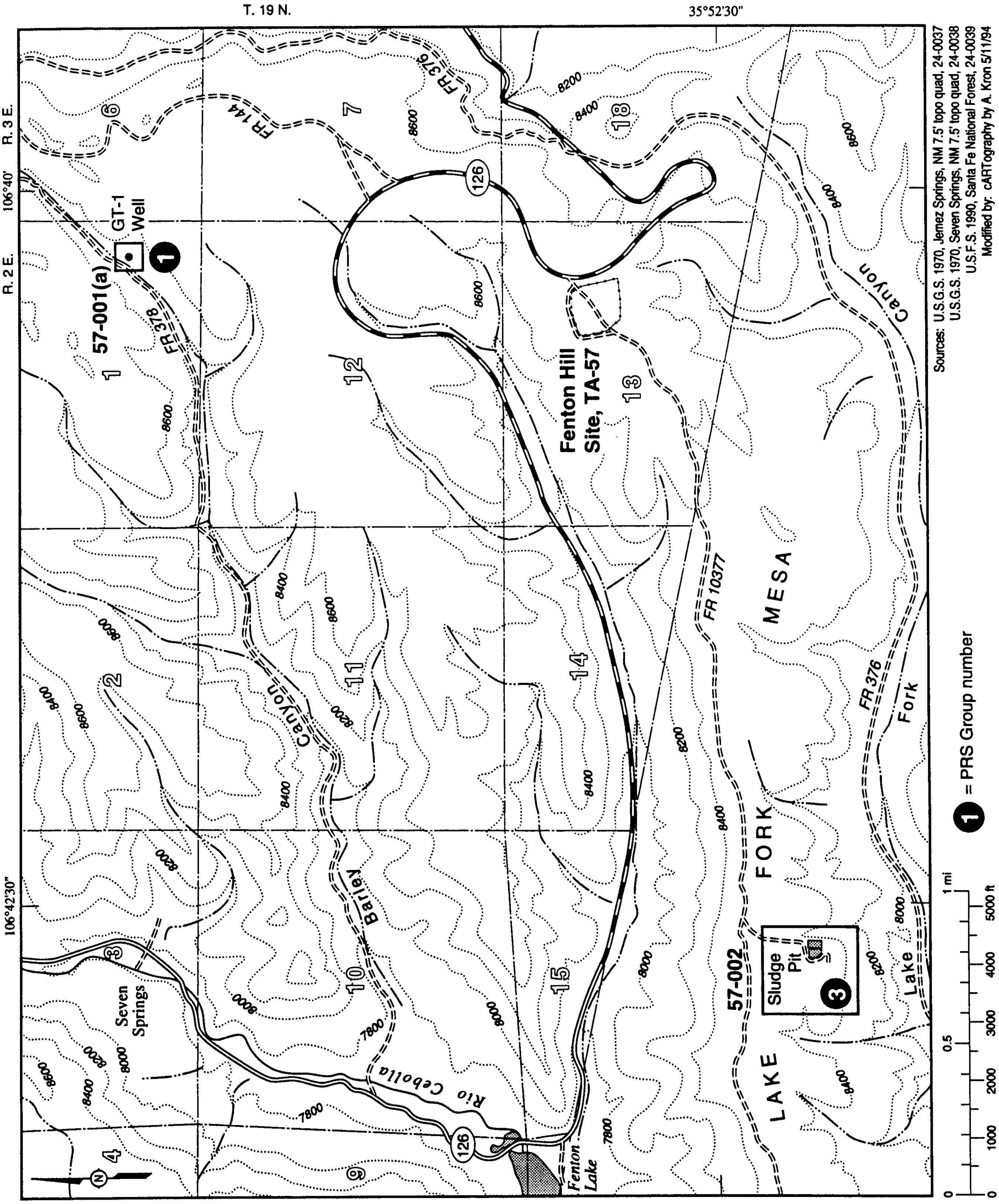


Figure 5-2. Locations of outlying Fenton Hill PRS Groups.

TABLE 5-1

Summary of PRSs in OU 1154

Group	Description	No. of PRSs	No. of Sites Investigated	Phase I	NFA	DA	VCA
1	Drilling Mud Pits	1	7		7		
2	Settling Pond System	5	8	5	1	2	
3	Sludge Pit	1	1	1			
4	Chemical Waste Disposal	2	2	1			1
5	Container Storage Facility	1	2		1	1	
	Totals	10	20	7	9	3	1

5.2 GROUP 2: SETTLING POND SYSTEM

5.2.1 Description and History of Group 2 Sites

The settling pond system was started in 1974 in conjunction with the drilling of well GT-2 at TA-57. This system consists of five PRSs. Four of those PRSs are ponds of various sizes that were used for settling, experiments, and storage of the drilling and circulation fluids used during the operation of the circulation loop. They are discussed in this section. The fifth PRS is a filtration unit that was used to clarify the circulation fluid and is proposed for NFA. It is further discussed in Section 6.2.2.

Three of the ponds were excavated within the main compound of TA-57 and their sizes and shapes changed considerably over the years of their use. Figure 5-3 is a composite diagram showing the varying sizes and locations of these three ponds. The fourth pond is fenced and is located outside the main compound. The construction and operating history of each pond is summarized in Table 5-2.

Pond GTP-3 originated with the drilling of well GT-2. Pond GTP-3E (east) was originally used as the drilling mud pit for the drilling of well GT-2. As shown in Figure 5-3, pond GTP-3E was smaller than GTP-3W (west), and both ponds were used in conjunction with well GT-2. Because pond GTP-3W is much larger, (originally estimated to have been

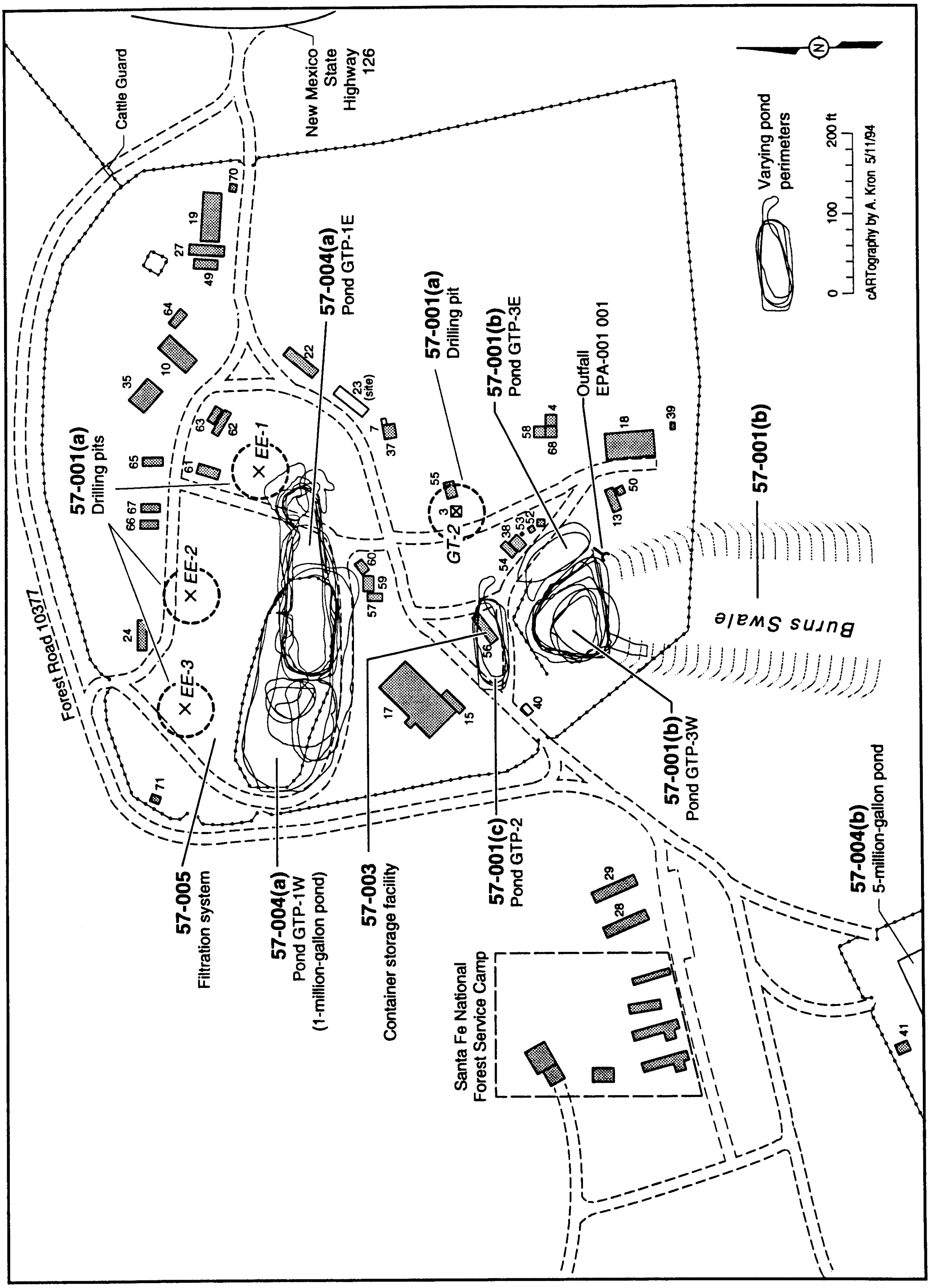


Figure 5-3. Composite diagram of varying settling pond systems.

TABLE 5-2

SETTLING POND SYSTEM SUMMARY

Pond ID	PRS ID	Date Pond Constructed	Surface Area of Pond in 1977 (m^2)	Current or Last Known Capacity of Pond (gal)	Primary Use of Pond	Date Pond Inactivated	Present Status of Pond
GTP-3*	57-001(b)	1974	600	750,000	Settling	1984	Backfilled
GTP-1*	57-004(a)	1975	1040	1,000,000	Settling	N/A	Active
GTP-2	57-001(c)	1976	260	~50,000	Experiments	1980	Backfilled
N/A	57-004(b)	1982	N/A	5,000,000	Storage	N/A	Active

* Because the location of ponds GTP-3 and GTP-1 changed considerably, each of these ponds has been given an east and west designation for the purposes of this work plan.

about 20-ft deep), and was also used in conjunction with the other deep drill holes at the site, it would be considered to have a higher potential for contamination for the investigation purposes of this work plan. Pond GTP-3W was created by constructing an approximately 10-ft-high berm across the head of Burns Swale, a natural drainage channel at the southern edge of the site. A spillway conducted overflow water around the west end of the berm and into the swale. Discharges into the swale were periodic rather than continuous. The bottom of the swale is currently covered with grass. There is localized evidence of stream erosion, but no continuous stream channel is present. Following decommissioning and cleaning, the pond was backfilled with large boulders and clean soil to form a flat surface at the elevation of the surrounding terrain. The area was also reseeded. Pond GTP-3E was filled with dirt and is now the site of a road. Little or no visual evidence remains of the GTP-3E or GTP-3W ponds.

Pond GTP-1 originated with the drilling of well EE-1. Pond GTP-1E was originally used as the drilling pit for the drilling of well EE-1, but was also used for circulation and settling of the drilling and circulation fluids from the circulation loop. Pond GTP-1E was originally excavated on level ground. It was cleaned of sludge and backfilled with clean soil to original ground level. The location of the western end of the pond continued to migrate and is now the site of pond GTP-1W, the currently active, one-million-gallon lined pond. Pond GTP-1W was lined in 1983-84 and again in 1990 after the original lining had deteriorated.

Pond GTP-2 was also originally excavated on level ground. It was used for experiments relating to the research of the HDR concept. The pond was cleaned of sludge and backfilled with clean soil to original ground level. This pond location is no longer evident.

The fourth pond, which has no pond number, is known as the five-million-gallon pond. It has been lined since it was built. It is currently active and is used primarily for storage of water to supply the circulation wells. However, it has also received fluid from pond GTP-1.

The original GTP-1 and GTP-3 ponds were used to provide settling for water used in drilling and circulation. They formed a two-stage system to remove particulates from the recirculating hydrothermal fluids by settlement. During most of the Fenton Hill drilling and experimental activities, drilling and circulation fluids first settled in pond GTP-1, and when pond GTP-3W was still active, the fluid was piped to that pond for final clarification prior to release. Once experimental circulation loops were established in the deep bedrock, the water in the loops was passed through the ponds for clarification. The ponds were repeatedly reconstructed to service changing experimental configurations. The reconstructions consisted of reshaping, by filling in parts of the ponds and enlarging other parts. As the ponds were reconfigured, the sludge in the bottom of the ponds was disposed in the sludge pit, which is described in Section 5.3.

Since pond GTP-3W was decommissioned, fluid from GTP-1 has flowed directly to EPA-permitted outfall 001 001 where it is discharged to Burns Swale. The location of this outfall is shown in Figure 5-3. The water is sampled prior to each release to assure that the EPA water quality standards are met.

Materials entering the system: Figure 5-4 shows the general hydraulic connections during both the drilling and circulation modes of operation in the Fenton Hill circulation system. The diagram indicates that the principal materials entering the system were fresh water from the on-site freshwater well (FH-1); drilling muds, which included barite and lubricating materials; and solids dissolved from passage through the rock underground.

The supply water also contained some dissolved solids. The water pumped from FH-1 tapped a freshwater aquifer in a buried valley at the base of the Cenozoic volcanics. Also, water was sometimes carted from Hofhein's well, at La Cueva, and, rarely, it was trucked from Los Alamos. These sources all carried some dissolved matter although probably not significant amounts.

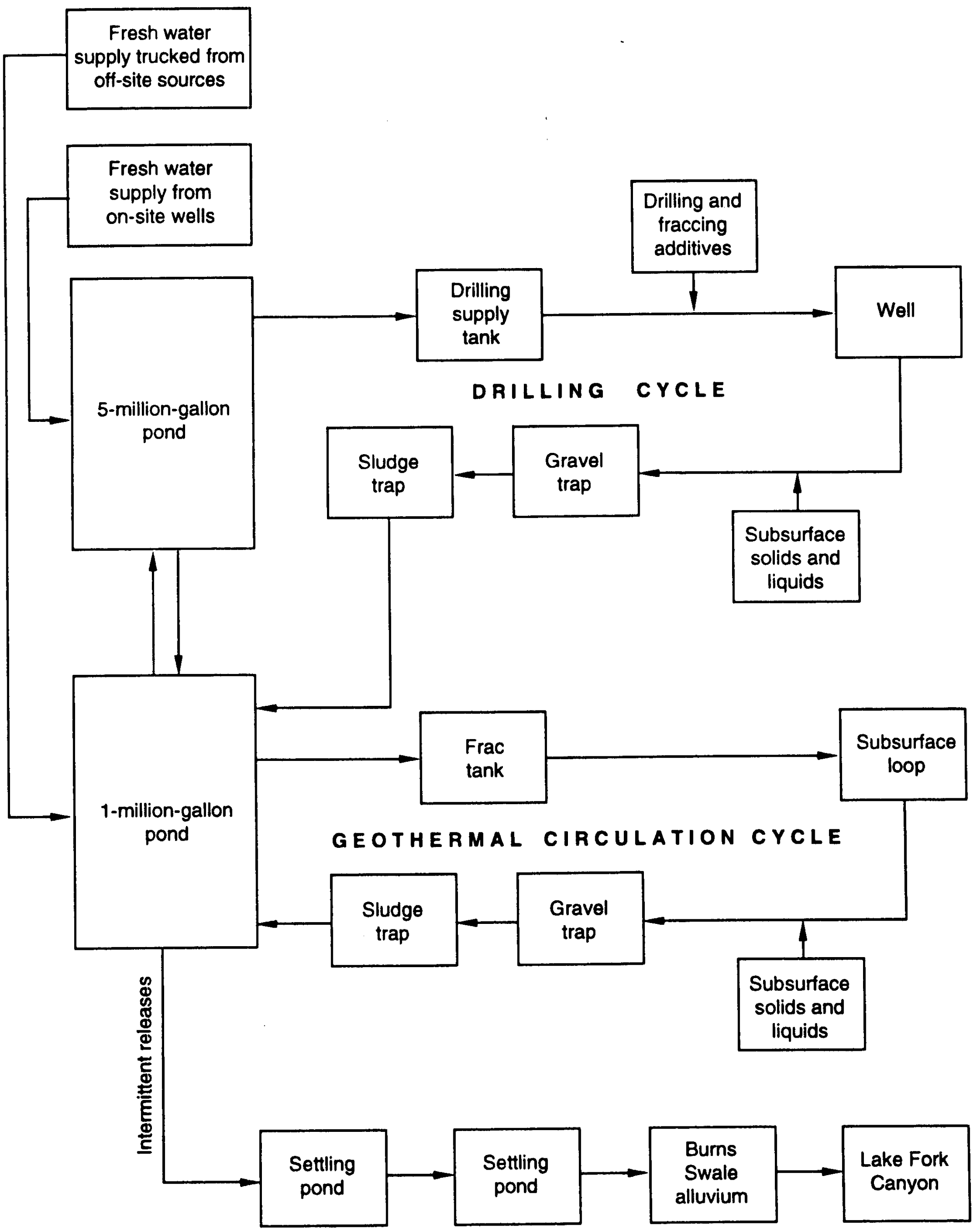


Figure 5-4. Fenton Hill process water flow diagram.

However, the solids that dissolved from passage through the deep circulation loop would be an important source of material entering the system. Water entered the underground loop cold and fresh, dissolved various materials on its path through the hot rock, and brought these materials to the surface. The mineralogy of the underground granite was described by Laughlin (1977, 24-0033). The changes made to the granite by the circulating water were studied by Ehrenberg and others (1977, 24-0034), Potter (1978, 24-0059), Charles (1979, 24-0040), and Charles & Bayhurst (1980, 24-0041). At the surface the returning solids in the waters were precipitated in the settling ponds. The result was a steady leaching of the underground reservoir, with transfer of soluble material to the settling ponds. This is a well-known process in the mining industry, termed "deep leaching." The effect of deep leaching was to add silica, carbonates, and metals to the settling ponds. In particular, deep leaching was the source of the enhanced arsenic and uranium found in the ponds in the early stages of operation (Purtymun et al. 1975, 24-0042; Zartman 1979, 24-0043). Water from the granite section of GT-2, at a depth of 990 m (3250 ft), had a total uranium concentration of 124 mg/l (Purtymun et al. 1975, 24-0042). This was regarded as normal for hot pore fluid in granite.

The effect of the deep leaching was enhanced by evaporation, which tended to increase solute concentrations in the ponds (Purtymun et al. 1980, 24-0045). Kaufman and Siciliano (1979, 24-0013) tabulated the mean quality of pond waters for the years 1977-78, as shown in Table 5-3.

Circulating water management practices: The quality of water taken through the settling ponds was of concern for both experimental and environmental reasons. Disposal of mineralized water from wet steam fields into both surface and ground water systems was known in other cases to have caused thermal and chemical pollution of fresh water systems and has killed natural aquatic flora and fauna (U.S. Fish and Wildlife Service 1976, 24-0048). Accordingly, water destined for surface disposal at Fenton Hill was continually monitored. A detailed historical review of operational measurements and control practices from 1974 through 1986, based upon a series of water quality reports by Purtymun and others issued annually over the life of the project, gives the details of the environmental monitoring in the area (Purtymun et al. 1973, 24-0072; Purtymun et al. 1974, 24-0061; LASL 1975, 24-0071; Purtymun et al. 1974, 24-0062; Purtymun et al. 1975, 24-0042; Pettitt 1976, 24-0051; Purtymun et al. 1976, 24-0050; Rea 1977, 24-0063; Purtymun et al. 1978, 24-0052; Purtymun 1978, 24-0053; Kaufman and Siciliano 1979, 24-0013; Purtymun et al. 1980, 24-0045; Langhorst 1980, 24-0065; Purtymun

TABLE 5-3

Chemical Characteristics of Pond Water, Ranges and Maxima Observed in 1977-78

Species	mg/l	Species	mg/l
SiO_2	85 - 300	Co	0.01
F^{-1}	2 -10	Ni	0.03
As	1	Cl^{-1}	200-1100
B	9	Cu	0.05
Cd	<0.1	Zn	<0.2
Hg^{+1}	<0.001	Ag	<0.02
Li	3.8-10	Sn	<0.1
Mo	0.04	Sb	<0.3
Se	0.004	Sr^{+2}	<0.8
Be	<0.01	Ba^{+2}	0.2
Na^{+1}	150-500	Pb	<0.03
Mg^{+2}	25	Bi	<0.1
Al^{+3}	1	HCO_3^{-1}	150-500
P	40	SO_4^{-2}	190
K^{+1}	65	PO_4^{-3}	0.9
Ca^{+2}	80	TSS	160
V	<0.03	TDS	2800
Cr	0.003	H_2S	<0.1
Mn	0.2	pH	6-8 pH units
Fe	6		

Source: Kaufman and Siciliano 1979, 24-0013

et al. 1980, 24-0046; Purtymun and Ferenbaugh 1981, 24-0047; Purtymun et al. 1981, 24-0055; Purtymun et al. 1983, 24-0056; Miera et al. 1984, 24-0068; Williams et al. 1986, 24-0077; Purtymun 1987, 24-0060; and Purtymun et al. 1988, 24-0058).

The water quality reports are briefly summarized as follows:

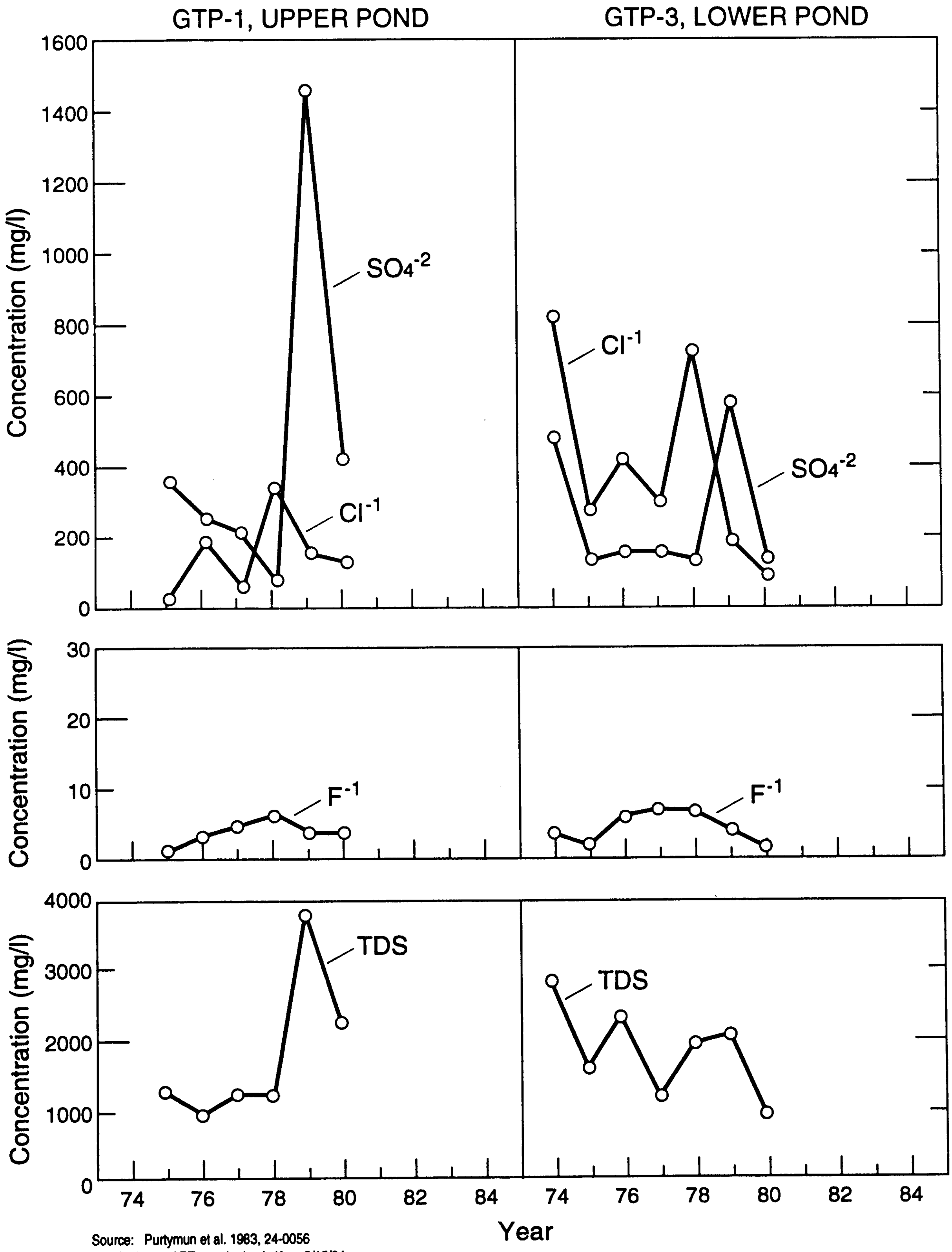
- The chemical characteristics and quality of the pond water varied extensively depending upon the type of operation in progress. The quality of the pond water varied with fresh water additions that replaced fluid losses and with the type of additive used prior to sample collection. The various additives kept drill cuttings in suspension or were materials that reduced fluid loss in sections of the boreholes. Also, the water used in experiments and drilling operations was returned to the ponds for reuse, so the quality usually deteriorated, while the chemical constituents, especially total dissolved solids (TDS), increased. Deep circulation and drilling operations also increased the TDS. Again, the circulating waters acted to leach minerals from the geothermal reservoir rocks, so the water became mineralized.

- Over the several year period of operations, the residual concentration of certain elements (for example, arsenic, lithium, boron and uranium) in the sludge and underlying tuff increased. In 1977, for example, pond water concentrations were above EPA disposal standards for chloride and fluoride, arsenic, and TDS. Figure 5-5 shows graphically the historical variation from 1974 to 1980 in ponds GTP-1 and GTP-3 for some of the more soluble ions. (Purtymun et al. 1983, 24-0056). The sharp increase in sulfate from 1978 to 1979 in GTP-1 is the result of drilling operations in EE-2 where the well penetrated several zones in the granite that contained trace amounts of sulfides (Purtymun et al. 1980, 24-0046).

- The residual solids in the ponds were removed and taken to the sludge pit.

Infiltration from Ponds: In order to evaluate infiltration from the settling ponds, Purtymun and others (1980, 24-0045) drilled seven test holes, ranging in depth from 6.7 to 19 m (22 to 62 ft), adjacent to the three ponds to determine if there was measurable sorbed concentrations of constituents resulting from infiltration into the underlying tuff. Using concentrations of chloride, fluoride, and uranium as indicators, seepage was inferred to have occurred in one hole south of GTP-1W to a depth of 6.7 m. Two holes near GTP-2 and GTP-3W indicated seepage to depths of 6.4 and 9.4 m (Table 5-4). The conclusion was that there was pond loss into the underlying tuff. The generally low fluoride concentrations indicated rapid uptake by the tuff. Infiltration rates were estimated to be 3.3 and 1.8 m annually, for GTP-1W and GTP-3W respectively. These infiltration rates refer to the equivalent depth of water that infiltrates over the surface area of the pond in one year. The volumes lost annually were estimated at 3.4 and 0.6 million liters, respectively. The water budget is given in Table 5-5. This shows that 31% of the water brought onto the site was lost by infiltration into the tuff.

Solid Disposal: The material scraped off the bottom of the ponds was sent to the sludge pit for disposal. An EPA toxicity test was performed before disposal to ensure that noxious materials could not be leached from it. For each truck load, the sludge at that time met the requirements for disposal to unlined, uncovered pits. Because somewhat different standards might apply today and the cumulative effect of



Source: Purtymun et al. 1983, 24-0056
Modified by: cARTography by A. Kron 3/15/94

Figure 5-5. Sulfate, chloride, fluoride, and total dissolved solids in Ponds GTP-1 and GTP-3 at Fenton Hill, 1974–1980.

TABLE 5-4

Soluble Chloride, Fluoride, and Total Uranium Extracted From Cuttings From Test Holes Around Pond, 1978

Distance from Pond	Depth (m)	No. of Analyses	Soluble Extract Cl^{-1} (mg/l)	F^{-1} (mg/l)	U(Total) (mg/l)
Pond GTP-1					
13 m Southwest	11	8	0.0 ± 0.0	0.3 ± 0.2	22 ± 22
6 m Southeast	11	8	0.4 ± 1.2	0.3 ± 0.2	22 ± 28
3 m South[a]	6.7	5	5. ± 3.6	0.6 ± 0.3	17 ± 3
10 m South	19	14	0.2 ± 0.8	0.2 ± 0.1	31 ± 26
Pond GTP-2					
3 m South	0-6.4	4	9.5 ± 3.9	4.6 ± 0.2	18 ± 11
	6.4-17	6	4.7 ± 4.8	0.2 ± 0.2	19 ± 17
Pond GTP-3					
3 m West	0-9.4	6	9.0 ± 4.6	0.4 ± 0.4	15 ± 5
	9.4-17	5	0.7 ± 1.6	0.2 ± 0.1	15 ± 10
6 m Southwest	14	10	1.0 ± 2.2	0.2 ± 0.1	26 ± 37
Control (Background)					
Hole 1	8.2	6	0.0 ± 0.0	0.2 ± 0.1	20 ± 13
Hole 2	10	7	0.0 ± 0.0	0.2 ± 0.1	17 ± 10
Hole 3	14	10	0.0 ± 0.0	0.2 ± 0.1	18 ± 20

[a]Test hole GTP-1.

Source: Purtymun et al. 1980, 24-0045, Table VI

disposing the sludge in one location might have concentrated some constituents, the current composition of the sludge will be investigated under this work plan.

The last principal output from the settling pond system was surface releases. Releases were planned when liquid levels in the settling ponds became high. Prior to each release, the water was sampled to ensure compliance with EPA standards for irrigation. If the water did not meet the standards, it was not released until the concentrations dropped. If necessary, water could also be pumped from pond to pond through a filtration system.

The only known exception to this operating practice occurrred in the early 1980s when a rapid spring snowmelt resulted in uncontrolled discharge over the GTP-3W pond spillway.

TABLE 5-5

Water Budget for Fenton Hill Facilities

Budget Item	Millions of Liters	%
Pond Evaporation	1.1	7
Pond Infiltration	5.1	31
Pond Discharge	3.5	21
Experiments and Site Use	6.8	41
Total	16.5	100

Source: Purtymun et al. 1980, 24-0045
Table VII

Although the pond water quality had not been sampled prior to that discharge, it is very likely to have met EPA standards because of dilution from the snowmelt.

Releases were made from the lower GTP-3W pond. From there the water flowed down a dry channel, Burns Swale, which leads to Lake Fork Canyon. The ponds were subject to National Pollution Discharge Elimination System (NPDES) requirements regarding arsenic, boron, cadmium, fluoride, and lithium (Purtymun and Ferenbaugh 1981, 24-0047), and the outfall is registered as EPA 001 001.

Discharges to Burns Swale began in 1974 (Purtymun & Ferenbaugh 1981, 24-0047). According to Purtymun and others (1978, 24-0052), when the lower pond was drained, the water was passed through columns of activated alumina and charcoal to remove fluoride and some organic dyes. Although the quality of the water in the muds occasionally exceeded EPA standards, the quality of the water that was released met EPA's proposed primary drinking water standards and generally met EPA's proposed standards for continuous irrigation and livestock consumption (Stoker et al. 1976, 24-0011; EPA 1975, 24-0073). An exception occurred in the fall of 1976 when a release from pond GTP-3 exceeded the continuous irrigation standards for boron (0.75 mg/l) and lithium (2.5 mg/l). The released water had a boron concentration of 5 mg/l and a lithium concentration of 10 mg/l. The water was released slowly and infiltrated completely in the dry stream bed within 300 m of TA-57.

Releases were recorded, including overflow from snow melt (Purtymun et al. 1976, 24-0050; Purtymun et al. 1978, 24-0052; Purtymun et al. 1981, 24-0045; Purtymun et al. 1980, 24-0046; Purtymun and Ferenbaugh 1981, 24-0047; Purtymun et al. 1981, 24-0055; Purtymun et al. 1983, 24-0056). There was only one discharge in 1985-86 (Purtymun et al. 1988, 24-0058). A report in 1987 showed that discharges had ceased (Purtymun et al. 1987, 12-0060).

The pond water quality was described as "slightly above discharge standards" (Purtymun et al. 1978, 24-0053) in both ponds, GTP-1 and GTP-3; as "deteriorating, due to sulfates and TDS" (Purtymun et al. 1980, 24-0046); as "highly mineralized" (Purtymun et al. 1980, 24-0046); and as having "elevated lithium and boron" (Purtymun et al. 1981, 24-0055). The release of March 1979, was described as "sulfatic" (Purtymun et al. 1980, 24-0046).

Accumulation in plants: Samples of vegetation from the bottom and banks of Burns Swale were collected semiannually to annually from the mid-1970s to the mid-1980s. Although the plant foliage showed no visual indication of stress, concentrations of boron and lithium were found to be within a range reported in the literature to have caused plant damage (Purtymun et al. 1983, 24-0056). Concentrations were highest in the foliage sampled in the swale bottom at a distance of about 200 m downstream of pond GTP-3. They peaked during 1981 and 1982 at about 700 ppm for boron and 150 ppm for lithium, and by 1986 had declined to maxima of about 60 ppm for both boron and lithium. The foliage was also analyzed for arsenic, cadmium, and fluoride, each of which was found at levels not considered toxic to the plants. As shown in Table 5-3, each of these elements was present in the pond water, which is thought to have been the source of these constituents in the downstream vegetation. The declining concentrations in the foliage coincide with the reduction or elimination of discharges following the large releases in the late 1970s and early 1980s (Purtymun et al. 1988, 24-0058).

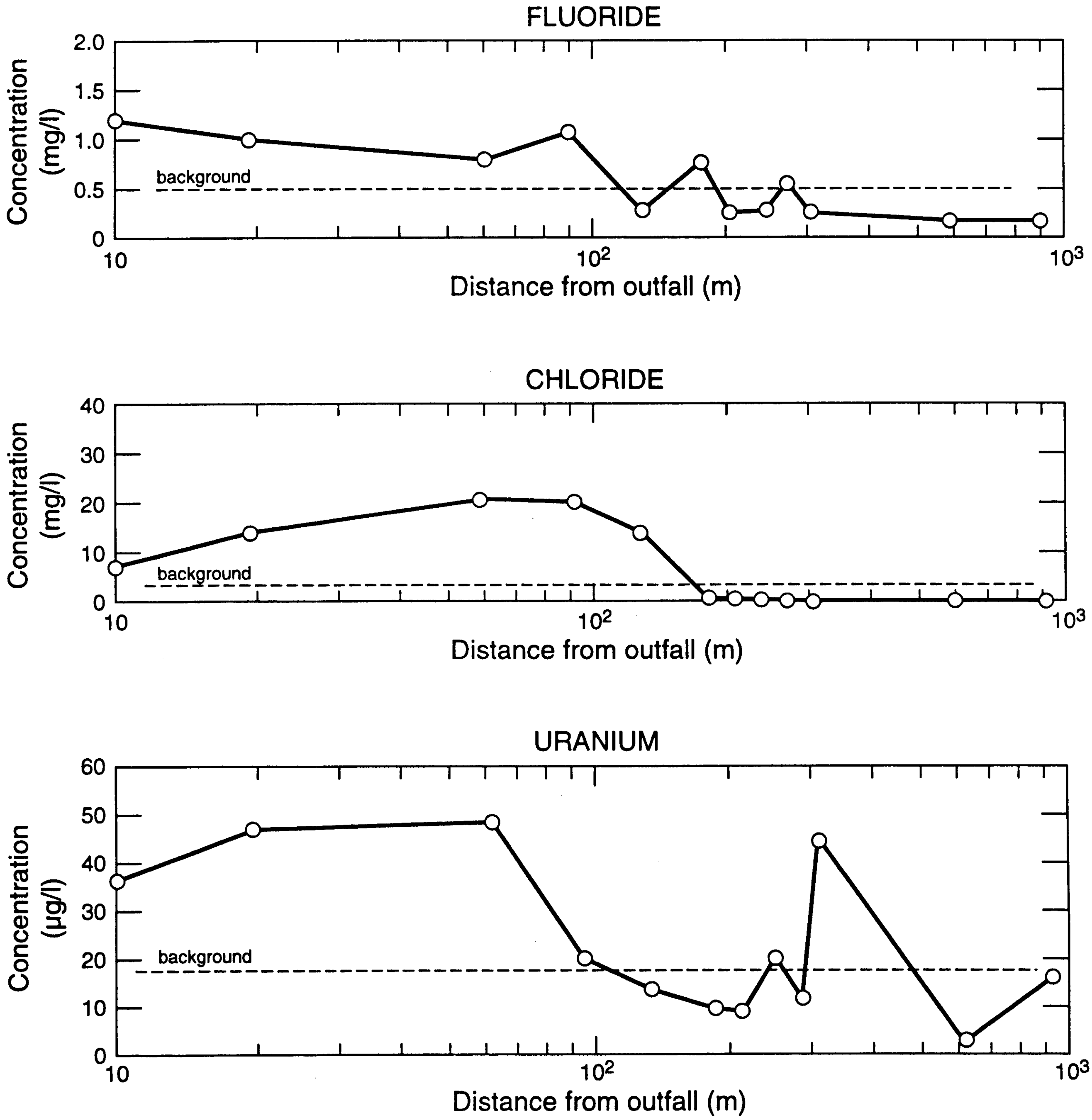
Following the discovery of boron and lithium accumulation in plant foliage, Purtymun conducted a number of detailed studies to try and understand the phenomenon (Purtymun et al. 1978, 24-0045; Purtymun et al. 1980; 24-0046; Purtymun et al. 1981, 24-0055; Purtymun et al. 1983, 24-0056; Purtymun et al. 1987, 24-0060; Purtymun et al. 1988, 24-0058). Samples were taken of foliage as well of the sediments and seepage water in the swale bottom. Of particular interest was the variation of soluble chemical constituents in the sediments downstream of pond GTP-3 because of their relationship to both the mobility of constituents in the discharged pond water and to the chemistry of the water available for plant uptake. The concentrations of soluble Cl, F, and U below the discharge point are shown in Figure 5-6. These data indicated that the released water had infiltrated the alluvium within 300 ft of the release point and that there was no effect farther downstream (Purtymun et al. 1980, 24-0046).

The results of Purtymun's studies showed that the accumulation in plants was localized to the region near the discharge point. It is possible that the effluent soaked through the alluvium and ponded on bedrock or collected in bedrock joints, from where it was picked up by the roots of vegetation. In such an arid climate, there is only the spring thaw to flush the alluvium, so concentrations increased over the ensuing months. This indicates that the leaves were the most sensitive indicator, more so than the auger holes drilled to bedrock. Since the levels in the leaves returned to background, this localized concentration seems to have been flushed away by annual thaws and elimination of further discharges of effluent.

5.2.2 Conceptual Exposure Model

During operation, releases of chemical constituents to the environment could have occurred through direct evaporation of pond water into the air, through leakage of water into the soil and bedrock beneath the ponds, and through seepage of discharge water into the soil and vegetation in Burns Swale. Airborne exposure routes are not considered significant because of the lack of elevated concentrations of volatile constituents and because airborne releases would have ceased when the ponds were decommissioned by cleaning and backfilling. However, chemical constituents from the pond water may remain sorbed on soil and bedrock beneath the pond sites.

The sludge in the bottom of the original ponds has been removed, and all but pond GTP-1W and the five-million-gallon pond have been backfilled with boulders and/or clean soil. Any constituents remaining in the underlying soil would be considered a subsurface source that could be mobilized by such processes as migration with percolating rainwater or snow melt. Chemical constituents may also remain sorbed on the soil in Burns Swale and would be considered a surface source. Such constituents could be mobilized by migration with surface run-off, or with percolating rainwater or snow melt, or through direct



Source: Purtymun et al. 1980, 12-0045
Modified by: cARTography by A. Kron 3/15/94

Figure 5-6. Variations in concentrations of selected soluble soil constituents with distance downstream of outfall in Burns Swale.

contact with the receptor. Detailed discussions of these and other potential exposure routes were presented in Section 4.4.

5.2.3 Remediation Decisions and Investigation Directives

The locations of the ponds in this group are shown in Figure 5-3. The location of pond GTP-1 [PRS 57-004(a)] has changed over time to a greater extent than any of the other ponds. The western end of this system of pond sites (GTP-1W) is now the location of the one-million-gallon lined pond that remains in active use. There is no evidence of leakage from this pond, and sampling beneath it will be deferred to D&D. No evidence of any releases to the environment was found for the filtration system used in association with this pond (PRS 57-005), which therefore will be recommended for no further action and is further discussed in Chapter 6.

The overlapping sites of the decommissioned members of the GTP-1E pond system, lying to the east of the currently active one-million-gallon pond, will be the focus of a Phase I investigation. Phase I sampling will be designed to determine the presence or absence of metallic and organic compound indicator constituents in the soil or bedrock that underlay the original pond. These indicator constituents are discussed in Section 5.2.5.2. If Phase I data indicate concentrations of constituents above both SALs and background levels, a Phase II investigation will be initiated to determine the nature and extent of contamination. The use of SALs and background levels in the decision strategy is explained in Chapter 4. The site of Pond GTP-2 [PRS 57-001(c)] will be the focus of the same type of Phase I investigation as Pond GTP-1E.

Pond GTP-3 [PRS 57-001(b)] has east and west locations. Both locations, GTP-3E and GTP-3W, were used for collecting drilling and circulation fluids from well GT-2. Because pond GTP-3E was smaller and lesser amounts of fluid were released into it, the pond will not be investigated at this stage of the RFI. The larger and more heavily used western pond, GTP-3W, will be the focus of the same type of Phase I investigation as Pond GTP-1E. Pond GTP-3W is the worse case between ponds GTP-3W and GTP-3E; therefore only pond GTP-3W will be sampled in Phase I. If hazardous constituents are found in GTP-3W, pond GTP-3E may need to be investigated as a subset of Phase I or in further investigations as part of Phase II.

Burns Swale is immediately downslope from Pond GTP-3W. It received discharge water from the GTP-3W and GTP-1 ponds and will be the focus of a Phase I investigation designed to determine the presence or absence of metal and organic compound indicator constituents in the soil at the bottom of the swale. If Phase I data indicate concentrations of constituents above both SALs and background levels, a Phase II investigation will be initiated to determine the nature and extent of contamination.

The five-million-gallon pond [PRS 57-004(b)] is an active, lined facility that shows no evidence of a release. Sampling beneath it will be deferred to D&D.

5.2.4 Data Needs and Data Quality Objectives

Source characterization data will be required to make the Phase I decision for the three ponds to be sampled. Data quality objectives specifications for these PRSs are as follows:

- **Inputs**. Concentrations of indicator constituents in samples of soil or bedrock underlying the original pond bottoms.

- **Boundaries**. Samples will be collected in vertical profiles starting at 3 ft beneath the present ground surface and continuing 2 ft into underlying bedrock or 4 ft into underlying soil beneath the original bottom of the pond.

- **Decision Logic**. If the maximum concentration from any laboratory sample exceeds the SALs and background levels for the indicator constituents, then proceed to Phase II to determine the nature and extent of contamination. Otherwise, recommend the PRS for no further action.

- **Design Criteria**. The samples from pond GTP-1E will be taken from a borehole at a location where all ponds in the GTP-1 system overlapped. Samples will also be obtained from one borehole per pond at GTP-2 and GTP-3W. Samples in each borehole will be taken at 1-ft intervals for field analysis, and one sample will be taken from the most highly contaminated horizon at each sampling location for laboratory analysis.

Source characterization data will also be required to make the Phase I decision for the sediments in Burns Swale. Data quality objectives specifications for these sediments are as follows:

- **Inputs**. Concentrations of indicator parameters in samples of soil from the bottom of the swale.

- **Boundaries**. Shallow samples will be collected at a depth of approximately 1 ft at locations downstream of pond GTP-3W where evidence of surface water flow is present. Deeper samples will be collected at the top of the bedrock surface underlying the shallow sample locations.

- **Decision Logic**. If the maximum concentration from any laboratory sample exceeds the SALs and background levels for the indicator constituents, then proceed to Phase II to determine the nature and extent of contamination. Otherwise, recommend this PRS for no further action.

- **Design Criteria**. Samples will be taken by hand methods at four locations to maximize the likelihood of detecting any contamination.

5.2.5 Sampling and Analysis Plan

5.2.5.1 Sampling Strategy and Objectives

Sampling actions at Group 2 sites are summarized in Table 5-6. Sampling will be performed in ponds GTP-1E, GTP-2, and GTP-3W, and in Burns Swale downstream of pond GTP-3W. Some of the PRSs in the group include more than one type of site. Sampling of the active, lined one-million-gallon and five-million-gallon ponds will be deferred to D&D because there is no evidence of an environmental release. Pond GTP-3E will not be sampled because the sampling in GTP-3W will indicate a worse-case scenario (see Section 5.2.3).

Because the ponds were cleared of sludge before backfilling with boulders and/or clean soil, the only significant remaining potentially contaminated media are the soil or bedrock

TABLE 5-6

Group 2 Sampling Actions

PRS No.	Type of PRS	Sampling Action	Rationale for Sampling Action
57-001 (b)	Pond GTP-3W	Sample	Potential environmental release
57-001 (b)	Pond GTP-3E	No sample	Use pond GTP-3W as surrogate
57-001 (b)	Burns Swale Sediments	Sample	Potential environmental release
57-001 (c)	Pond GTP-2	Sample	Potential environmental release
57-004 (a)	Pond GTP-1E	Sample	Potential environmental release
57-004 (a)	GTP-1W	No sample	Defer to D&D
57-004 (b)	5 M Gallon Pond	No sample	Defer to D&D
57-005	Filtration system	No sample	No environmental release

underlying the pond sites. Chemical constituents could have been transported into these media by water seeping through the bottoms of the ponds. Similarly, chemical constituents could also have been transported into the surface and subsurface soils in Burns Swale.

5.2.5.2 Indicator Constituents

The Group 2 indicator constituents are summarized in Table 5-7. Many chemical species were used at Fenton Hill or could potentially have been dissolved from the underlying bedrock; however, only those that would pose a potential health hazard, that were used or produced in the greatest quantity, and that would be good indicators of a release were selected as indicator constituents for Phase I sampling. All Group 2 soil, sediment, and bedrock samples will be analyzed for metals and for SVOCs. Because a wide variety of metals could have been present, the samples will be analyzed for the metals listed in the extended analyte list in Chaper 4. Although not considered toxic to humans, analyses will be performed for lithium, which was found in elevated concentrations in the sediments in previous sampling (see Section 5.2.1) and may be an environmental toxin. Lithium is not considered toxic to humans but can be an environmental toxin, and is being sampled for future use in ecological risk assessments. Analyses will also be performed for SVOCs that may have been present in the drilling fluid additives.

Results of chemical analyses of the pond water and sludges were used to help select the specific indicator constituents. Most metals are thought to have originated from dissolution of native bedrock in the deep geothermal production zone. Beryllium, antimony, arsenic, thallium, lithium, uranium, cadmium, and chromium are among the indicators that may have come from such dissolution. In addition, barium and SVOCs may be present from the drilling fluids.

TABLE 5-7

Group 2 Indicator Constituents

PRS 57-001 (b), 57-001 (c), and 57-004 (a), soils, bedrock, and sediments

Chapter 4 Extended Analyte List Metals and SVOCs[a]

[a] See Table 4-4.

5.2.5.3 Sampling Plan

Samples will be taken at each of the three pond sites from a single borehole at each site, as shown in Figure 5-7. One borehole is expected to provide representative data for each pond system because the chemical constituents carried by percolating pond water into the underlying soil or porous tuff would have been the same at any location beneath the pond. These media are relatively uniform in character beneath the site and are expected to be relatively homogeneous with respect to sorptive characteristics. The boreholes will be located where ponds of different ages overlapped, enabling the sample to also be representative of any variations in pond water chemistry that may have occurred over time.

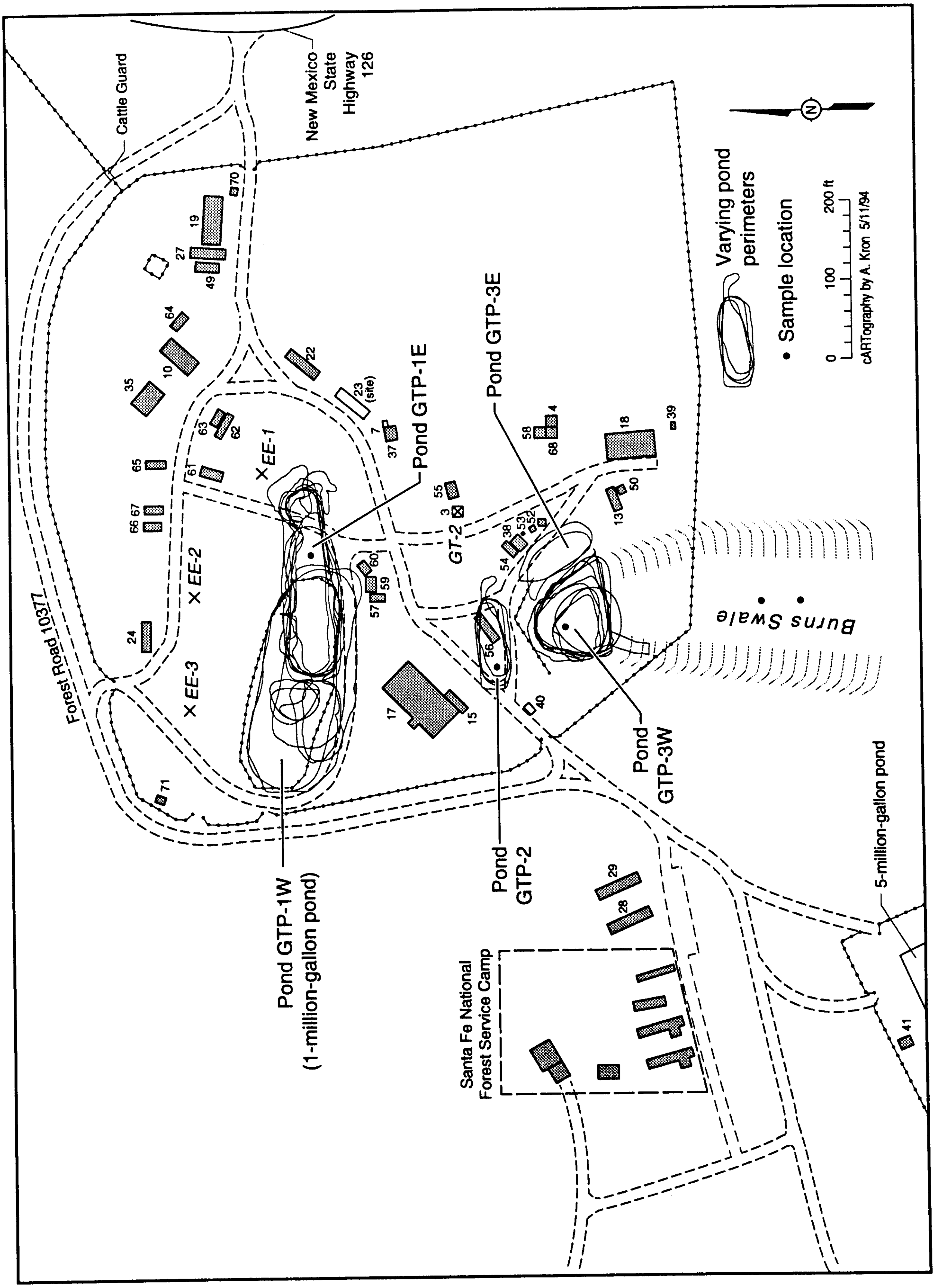


Figure 5-7. Sample locations for Group 2—Pond System.

Ponds GTP-1E and GTP-2 are estimated to have been about 12-ft deep at the sampling locations, while pond GTP-3W is estimated to have been about 20-ft deep. Each borehole will be drilled with the objective of obtaining a sample from the underlying native soil or bedrock. Each hole will extend a nominal 10 ft beneath the expected pond bottom; thus the boreholes at the GTP-1E and GTP-2 sites are expected to be 22-ft deep, and the hole at GTP-3W is expected to be 30-ft deep. However, deeper holes will be drilled if needed to penetrate at least 10 ft into the native underlying soil or bedrock.

Pond GTP-3W is reported to have been backfilled with large boulders as well as soil, and boulders may also have been placed into the other ponds. The boulders were reportedly taken from a local road construction project. They are of unknown rock type and may refuse an auger bit, in which case a rotary core bit may be required. If the boulders are of the same rock type as the underlying Bandelier Tuff bedrock, the minimum 10 ft of required penetration is expected to be sufficient to distinguish between the boulders and bedrock.

Beginning at a depth of 3 ft, samples will be taken at 1-ft intervals for field x-ray fluorescence (XRF) and organic vapor analyzer (OVA) or photo-ionization detector (PID) analysis, and also at horizons providing visual or other evidence of high constituent concentrations. Samples will be taken for laboratory analysis at the horizon determined from field information to have the highest constituent concentrations. This approach has been adopted because the original depths of the ponds are not precisely known. It is expected that this sample will be taken in the rock or sediments beneath the bottom of the original pond, because clean backfill materials were used. One sample from each hole will be taken for metals, and another for SVOCs. Because the samples will be taken at the most highly contaminated horizons, the sample for metals may be taken at a different horizon than the sample for SVOCs. If no horizon of high constituent concentration is found in the field screening, the sample will be taken from the bottom of the hole.

Shallow sediment samples will be taken by hand methods at two locations in Burns Swale, as shown in Figure 5-7. The first location is approximately 100 ft downstream of the point where the site fence crosses the swale, and the second is about 150 ft downstream of the fence. These sampling locations are within the zone of high concentrations of fluoride, chloride, and uranium, shown in Figure 5-6. Each sample is to be taken from the bottom of an eroded channel within the swale, where evidence of surface water movement is present. This channel is normally dry and is expected to be dry at the time of sampling. One sample is to be taken for laboratory analysis at a depth of 1 ft at each location. A second sample will be taken of the sediment at the top of the bedrock surface directly beneath each of the shallow sampling locations. Bedrock is expected at a depth of three to eight feet at each location, and hand augering methods are expected to be used. Field screening is only required at these locations for health and safety purposes.

Quality assurance samples will be taken in accordance with the requirements of the QAPjP presented in Annex II. The types of quality assurance samples and the minimum numbers of samples are summarized in Table 5-8. The sampling locations for the quality assurance samples will be determined by the Field Team Leader following criteria presented in Chapter 4.

TABLE 5-8

Group 2 Sampling Types

Medium	Number of Site Samples	Expected Number of QA Samples[a]	Total Samples
PRS 57-001 (b), 57-001 (c), and 57-004 (a) Ponds			
Soil or bedrock-field XRF	43	3	46
Soil or bedrock-laboratory	6	3[b]	9
PRS 57-001 (b) Swale			
Sediments	4	3[b]	7

a Field Blank: The greater of one in 20 samples or one per sampling round.
Duplicate Sample: The greater of one in 20 samples or one per sampling round. Note that all field XRF QA samples are duplicate samples.
Equipment (Rinsate) Blank: The greater of one in 20 samples or one per sampling round. .

b The same QA samples may be used for both soil/bedrock and sediment sampling if taken in the same sampling round.

All information pertinent to the sampling activity will be documented in the field log as specified in Section 4.3.7. All sampling sites will be marked for later geodetic surveying. The sampling procedures are listed in Table 5-9, and are drawn from the generic lists presented in Annex II. Health and safety procedures for field activities are listed in Annex II

TABLE 5-9

Group 2 Sampling Procedures

Activity	Procedure
General Sampling Instructions	See Annex II
Field Health and Safety	See Annex II
Drilling Methods and Drill Site Management	LANL-ER-SOP-4.01
General Borehole Logging	LANL-ER-SOP-4.04
Spill Control During Drilling	TBD[a]
Spade and Scoop Method for Collection of Soil Samples	LANL-ER-SOP-6.09
Hand Auger and Thin-Wall Tube Sampler	LANL-ER-SOP-6.10
Stainless Steel Surface Soil Sampler	LANL-ER-SOP-6.11
Sediment Material Collection	LANL-ER-SOP-6.14
Sample Collection from Split Spoon Samplers and Shelby Tube Samplers	LANL-ER-SOP-6.24
Core Barrel Subsurface Sampling	LANL-ER-SOP-6.26
Field Logging, Handling, and Documentation of Borehole Materials	LANL-ER-SOP-12.01

a Procedure number to be determined; procedure is in preparation and will be finalized prior to initiation of Phase I drilling and sampling activity.

b Procedure is in preparation and will be finalized prior to initiation of Phase I drilling and sampling activity.

and should be reviewed prior to any sampling activity. Long-term archival storage is not expected to be required for any samples produced under this work plan. Any sample residuals and all waste decontamination solutions will be disposed of in accordance with LANL-ER-SOP-01.6 (LANL 1992, 0668).

5.3 GROUP 3: SLUDGE PIT

5.3.1 Description and History of Group 3 Site

The sludge pit was used between 1974 and 1990 as a disposal area for the sludge that was cleaned out of the settling ponds, GTP-1, GTP-2, and GTP-3, and the mud from the drilling mud pits. It is the former site of a gravel, or borrow, pit that was used by the State of New Mexico in conjunction with the building of State Road 126. The pit is located about 2 miles west of the main compound of TA-57 on U.S. Forest Service property, and is shown in Figure 5-2.

The dimensions of the entire pit are approximately 200 by 100 ft, with the western section occupying about two-thirds of the total area. The pit was divided into two sections, referred to as the east and west sides for the purposes of this work plan. The western side, reported to be about 15- to 20-ft deep (Burns 1993, 24-0054), was used during the early stages of operation at Fenton Hill. It was active until about 1985 when disposal started in the eastern section. Although the western side was reseeded after use and currently has grasses and shrubs growing on it, visible signs of the Fenton Hill disposal operations remain. For example, remains of the plastic lining installed in the GTP-1 pond in 1983 and 1984 are clearly visible.

The eastern section of the pit was last used in 1990 when the GTP-1W pond was recontoured, cleaned, and relined. The sludge from the cleaning operation was trucked from TA-57. The trucks backed up to the north end of the pit and dumped the sludge, which was then pushed toward the south with a bulldozer. The sludge—typically very wet and sloppy—was easily maneuvered.

The south end of the eastern side of the pit is bermed. However, when the water in the sludge did not evaporate or soak into the sludge pit at a sufficient rate, personnel would breach the berm and allow the water to flow to a graded area where it would evaporate faster. The eastern side of the pit is estimated to be about 6- to 8-ft deep.

At one time, the eastern side of the pit was surrounded by a barbed-wire fence and large boulders. The fence has been torn down and is no longer useful in keeping unsuspecting visitors, human or animal, out of the pit. At a site visit in the summer of

1993, the eastern side was observed to be noticeably softer than the western section. The sludge was analyzed by Fenton Hill personnel prior to disposal in the sludge pit. Although each individual analysis indicated the sludge met any restrictions imposed according to the agreement between the DOE and the U.S. Forest Service. It is not known what standards or quality assurance requirements were followed.

5.3.2 Conceptual Exposure Model

During operation, releases of chemical constituents to the environment could have occurred from the sludge pit through direct evaporation, volatilization, or resuspension, and through leakage of liquids into the soil and bedrock beneath the site. Airborne exposure routes remain viable at this site, because organic odors—an indication of potential inhalation exposure routes— were noticed by team members during a site visit in the summer of 1993, and part of the pit is not vegetated. In addition, chemicals from the original sludge water or chemicals more recently leached from the sludge by natural precipitation may be sorbed on soil and bedrock beneath the site.

The sludge itself is present on the ground surface over part of the site and would be considered a surface source for exposure models. Such constituents could be mobilized by migration with surface run-off, or with percolating rainwater or snow melt, or through direct contact with the receptor. Over the balance of the site the sludge is covered by soil. The covered sludge and any constituents present in the underlying soil and bedrock would be considered a subsurface source that could be mobilized by such processes as migration with percolating rainwater or snow melt. Detailed discussions of these and other potential exposure routes are presented in Section 4.4.

5.3.3 Remediation Decisions and Investigation Directives

The location of the sludge pit is shown in Figure 5-2. The pit is considered to contain potentially hazardous constituents and will be the focus of a Phase I investigation. Phase I sampling will be designed to determine the presence or absence of metallic and organic indicator constituents in the soil or bedrock that underlie the site. These indicator parameters are discussed in Section 5.3.5.2. If Phase I data indicate concentrations of these constituents above both SALs and background levels, a Phase II investigation will be initiated to determine the nature and extent of contamination.

5.3.4 Data Needs and Data Quality Objectives

Source characterization data will be required to make the Phase I decision for the sludge pit. Data quality objectives specifications for this PRS are as follows:

- **Inputs**. Concentrations of indicator constituents in samples of sludge and in samples of the soil or bedrock underlying the site.

- **Boundaries.** Samples will be collected in vertical profiles starting at the present ground surface and continuing 1 ft into the underlying soil or bedrock.

- **Decision Logic**. If the maximum concentration from any laboratory sample exceeds the SALs and background levels for the indicator constituents, then proceed to Phase II to determine the nature and extent of contamination. Otherwise, recommend this PRS for no further action.

- **Design Criteria**. Samples will be taken from boreholes at two locations within the sludge pit. Samples will be taken at 1-ft intervals for field analysis, and one sample will be taken from the most highly contaminated horizon at each sampling location for laboratory analysis.

5.3.5 Sampling and Analysis Plan

5.3.5.1 Sampling Strategy and Objectives

Sampling actions at the Group 3 site are summarized in Table 5-10. The sludge pit is surrounded by a perimeter berm and is physically divided into eastern and western sections by a central berm. Both sections will be sampled. Sampling will be performed from two boreholes, one drilled in each section of the pit. Chemical constituents may be found in the sludge and in the underlying soil or bedrock. Although excess water transported with the sludge is reported to have periodically flowed through the berm and ponded on the bedrock surface south of the pit, samples will not be taken in that area because any chemical constituents in the water would also be present as residuals in the

TABLE 5-10

Group 3 Sampling Actions

PRS No.	Type of PRS	Sampling Action	Rationale for Sampling Action
57-002	East Sludge Pit	Sample	Potential environmental release
57-002	West Sludge Pit	Sample	Potential environmental release

sludges in the pit. However, sampling will be performed south of the pit if COCs are found to be present in the Phase I sampling.

5.3.5.2 Indicator Constituents

The Group 3 indicator constituents are summarized in Table 5-11. These sludges were removed from the Group 2 settling ponds and would be expected to have similar chemical constituents. The indicator constituents are therefore the same as for the Group 2 sampling. Sludge, soil, and bedrock samples from the sludge pit will be analyzed for the indicator constituents shown in the table.

TABLE 5-11

Group 3 Indicator Constituents

PRS 57-002 sludges, soils, and bedrock

Chapter 4 Extended Analyte List Metals and SVOCs[a]

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a See Table 4-4.

5.3.5.3 Sampling Plan

Samples will be taken in the east and west pit sections from a single borehole in each section, as shown in Figure 5-8. One borehole is expected to provide representative data for each section because the constituents would have been similar from pond to pond, and because the low-viscosity sludge would have flowed laterally across the surface of the pit after it was dumped. Each borehole is expected to penetrate essentially all sludge layers present.

The western section of the pit is expected to be about 15- to 20-ft deep, and the eastern section is expected to be about 6- to 8-ft deep. The bottom of each pit segment is known to lie in bedrock because of its original use of the pits as a gravel quarry. Each borehole will be drilled 10 ft into the underlying bedrock. Beginning at the ground surface, samples will be taken at 1-ft intervals for field XRF and OVA or PID analysis, and also at horizons providing visual or other evidence of high constituent concentrations. The last sample will be taken from the bedrock at the bottom of the hole. The greatest constituent concentrations in the bedrock are expected to be near its upper surface because the low-permeability muds in the pits would limit infiltration of natural precipitation.

Samples will be taken for laboratory analysis at the horizon determined from field information to have the highest constituent concentrations. One sample from each hole will be taken for metals, and another for SVOCs. Because the samples will be taken at the most h ighly contaminated horizons, the sample for metals may be taken at a different horizon than those for the organics. Although the pit site is generally level, the sludges may have low bearing capacities and should be tested prior to driving heavy drilling equipment over them. The older western section was closed in about 1985 and is expected to be more stable than the newer eastern section.

Quality assurance samples will be taken in accordance with the requirements of the QAPjP in Annex II. The types of quality assurance samples and the minimum numbers of samples are summarized in Table 5-12. The sampling locations for the quality assurance samples will be determined by the Field Team Leader in accordance with the criteria in Chapter 4.

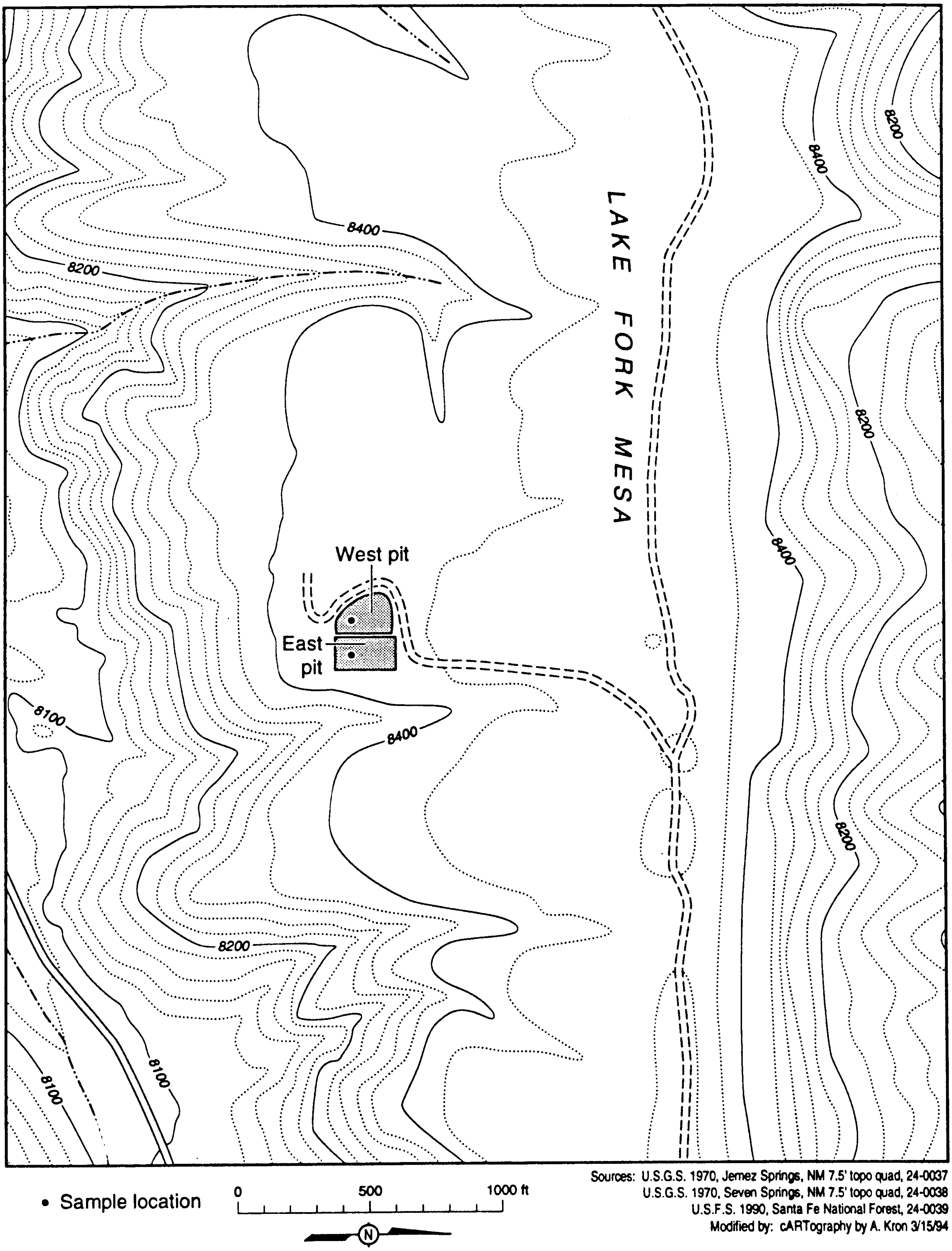

Figure 5-8. Sample locations for Group 3—Sludge Pit.

All information pertinent to the sampling activity will be documented in the field log as specified in Section 4.3.7. All sampling sites will be marked for later geodetic surveying. The sampling procedures are listed in Table 5-13, and are drawn from the generic lists presented in Annex II. Health and safety procedures for field activities are listed in Annex II and should be reviewed prior to any sampling activity.

TABLE 5-12

Group 3 Sampling Types

Medium	Number of Site Samples	Expected Number of QA Samples[a]	Total Samples
PRS 57-002 Sludge Pit			
Sludge, Soil or bedrock-field XRF	48	3	51
Sludge, Soil or bedrock-laboratory	4	3	7

a Field Blank: The greater of one in 20 samples or one per sampling round.
Duplicate Sample: The greater of one in 20 samples or one per sampling round. Note that all field XRF QA samples
are duplicate samples.
Equipment (Rinsate) Blank: The greater of one in 20 samples or one per sampling round..

TABLE 5-13

Group 3 Sampling Procedures

Activity	Procedure
General Sampling Instructions	See Annex II
Field Health and Safety	See Annex II
Drilling Methods and Drill Site Management	LANL-ER-SOP-4.01
General Borehole Logging	LANL-ER-SOP-4.04
Spill Control During Drilling	TBD[a]
Sample Collection from Split Spoon Samplers and Shelby Tube Samplers	LANL-ER-SOP-6.24
Core Barrel Subsurface Sampling	LANL-ER-SOP-6.26
Field Operation of X-Ray Fluorescence Instrumentation	TBD[a]
Field Logging, Handling, and Documentation of Borehole Materials	LANL-ER-SOP-12.01[b]

a Procedure number to be determined; procedure is in preparation and will be finalized prior to initiation of Phase I drilling and sampling activity.

b Procedure is in preparation and will be finalized prior to initiation of Phase I drilling and sampling activity.

5.4 GROUP 4: CHEMICAL WASTE DISPOSAL AREAS

5.4.1 Description and History of Group 4 Sites

A chemistry trailer was used at the Fenton Hill site from about 1976 to 1989 to provide real-time data analyses of the drilling needs, the circulating geothermal fluids, the sludge at the bottom of the settling ponds, and other activities requiring analytical services. The trailer was specifically outfitted to serve as a chemistry laboratory. Pipe lines from the circulation loop were tapped into the trailer to allow the chemists to take samples as the fluid was actually circulating through the wells.

A sink in the trailer provided fresh water from FH-1, the on-site fresh water supply well. The sink drained to a buried leach field located about 20 feet southeast of the trailer. The open bottom leach field was about 8- to 10-ft deep, constructed with cinder blocks and filled with gravel. Although the chemists were selective about which chemicals were dumped into the sink drain, some less hazardous chemicals were diluted with water and poured into the drain.

Other chemicals that were considered to be too dangerous or toxic for the sink drain were poured into a special drain that was connected to a plastic lined 55-gallon drum buried in the ground beneath the trailer. This drum was reported to have been emptied one or two times throughout the lifetime of activities in the trailer, and the waste was disposed at the main Laboratory (Burns 1993, 24-0044).

In the spring and summer of 1993 the contents of this drum were sampled. The resulting analysis indicated that highly elevated levels of lead, mercury, and a variety of spent organic solvents remained in the drum. The contents of the drum were removed by the Laboratory's waste management group in January 1994. An independent voluntary corrective action plan is being developed to remove the drum itself and any potentially contaminated soil underneath the drum during 1994. Consequently, the sampling activities described in this work plan only address potential contamination at the leach field. Currently, about 2 inches of the top of the drum, which is visibly corroded, remains aboveground. The trailer has been removed from the site.

5.4.2 Conceptual Exposure Model

Releases from the leach field would have been limited to the underlying soil. Releases to the air are considered negligible because the leach field was an underground system. Chemical constituents may be sorbed on the soil and gravel in and beneath the leach field from liquids that were discharged into the drain. Any constituents in the gravel or underlying soil would be considered a subsurface source that could be mobilized by such processes as migration with percolating rainwater or snow melt. The tank contents are not accessible to wind and could not be mobilized by that mechanism. Detailed discussions of these and other potential exposure routes are presented in Section 4.4.

5.4.3 Remediation Decisions and Investigation Directives

The locations of the drum and sink drain pipe are shown in Figure 5-9 along with the expected location of the leach field. The drum contained potentially hazardous concentrations of lead, mercury, and solvents. The contents of the drum have been removed, and the drum itself will be removed through a voluntary corrective action independent of the activities conducted under this work plan. The exact location of the leach field associated with the trailer's sink drain pipe is not known and will be determined at the time of sampling. The soil underlying the leach field will be subjected to a Phase I investigation. Phase I sampling will be designed to determine the presence or absence of metallic and volatile organic indicator constituents. These indicator constituents are described in Section 5.4.5.2. If Phase I data indicate concentrations of constituents above both SALs and background levels at the site, a Phase II investigation will be initiated to determine the nature and extent of contamination at that site.

5.4.4 Data Needs and Data Quality Objectives

Source characterization data will be required to make the Phase I decision for the soil to be sampled. Data quality objectives specifications for the leach field are as follows:

- **Inputs.** Concentrations of indicator constituents in a sample of soil and gravel in the leach field.

- **Boundaries**. The sample will be collected at a depth of zero to 12 in. in the leach field beneath the end of the drain line.

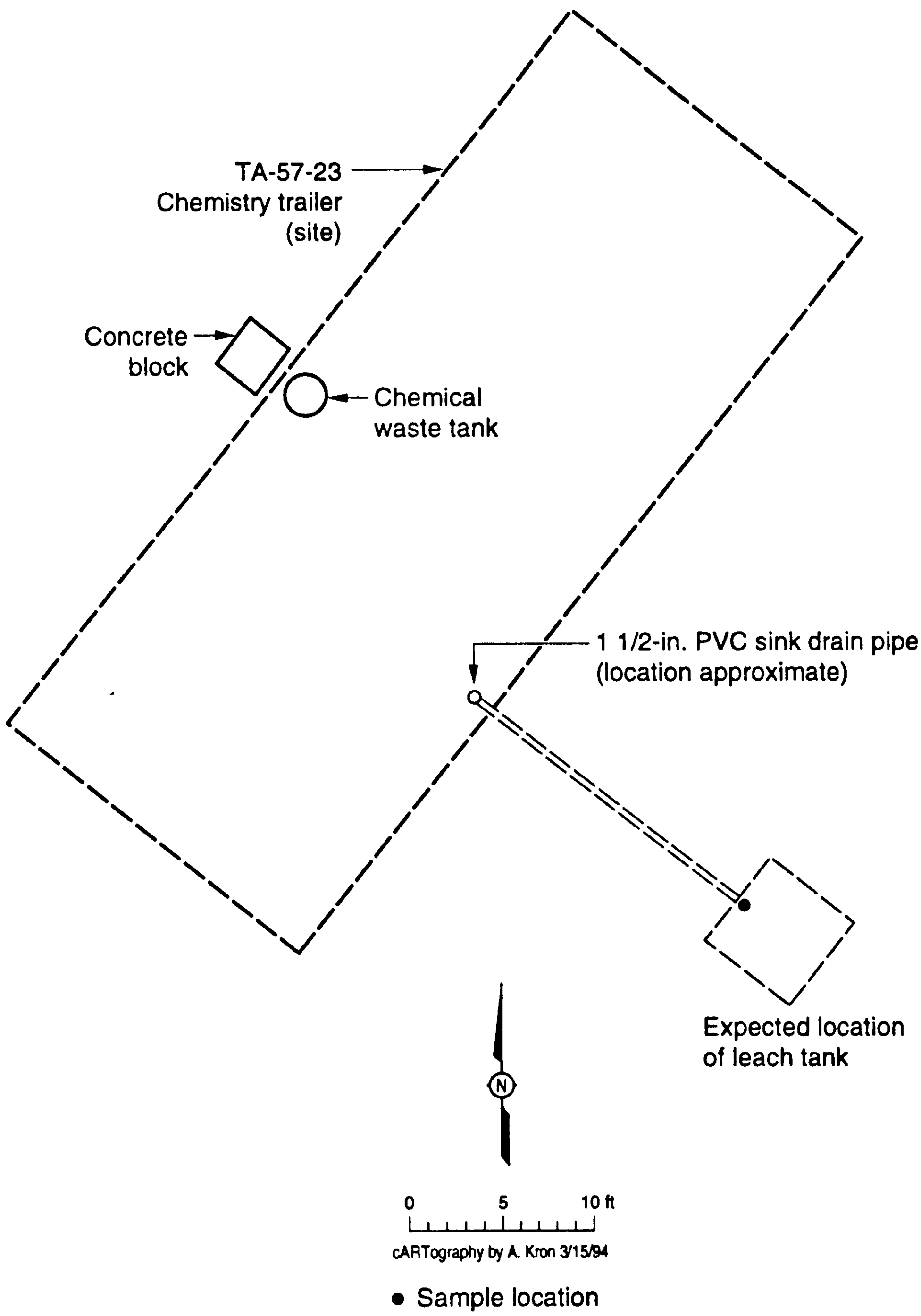

Figure 5-9. Sample locations for Group 4—Chemistry Trailer Facilities.

- **Decision Logic.** If the maximum concentration from the laboratory sample exceeds the SALs and background levels for the indicator constituents, a voluntary corrective action will be initiated to remove the contaminated material. Otherwise, recommend this PRS for no further action. No Phase II sampling is expected for this site.

- **Design Criteria.** The sample will be taken using hand sampling techniques at a judgmental location where the highest concentration of chemical constituents is expected, based upon field screening data, visual observations, and other information. Because of the small expected size of the leach field, only one sample is needed to provide representative information.

5.4.5 Sampling and Analysis Plan

5.4.5.1 Sampling Strategy and Objectives

Sampling actions at the chemistry trailer sites are summarized in Table 5-14. Sampling of the drum contents has been conducted, and the results will be used to plan and implement an independent voluntary corrective action. The VCA plan will be prepared as a separate document. The soil under the leach field will be sampled under this work plan to identify any environmental contamination that may have occurred from the disposal of chemicals into the leach field.

5.4.5.2 Indicator Constituents

The Group 4 indicator constituents are summarized in Table 5-15. Although most analyses performed in the chemistry trailer were for metals and involved primarily metal salts, some analyses were also performed for organic compounds that used organic solvents. The three constituents that were found in elevated quantities in the chemical waste drum were lead, mercury, and 1,1,2-trichloro-1,2,2-trifluoroethane. Because a variety of metals or organic solvents could have entered the leachfield, analyses will be performed for the Chapter 4 Extended Analyte List metals and VOCs.

TABLE 5-14

Group 4 Sampling Actions

PRS No.	Type of PRS	Sampling Action	Rationale for Sampling Action
TBD[a]	Drum contents	No sample	Sampling completed and tank expected to be removed as part of an independent voluntary corrective action.
TBD[a]	Leach field soil	Sample	Potential environmental release

a A PRS number has been requested for the chemistry trailer sites.

TABLE 5-15

Group 4 Indicator Constituents

Leach Field Soil

Chapter 4 Extended Analyte List Metals and VOCs

a See Table 4-4.

5.4.5.3 Sampling Plan

One sample of soil and gravel in the leach field will be taken. Although hand techniques will be used to collect the sample, it may be necessary to locate the leach field using power excavating equipment. The location of the drain line is shown in Figure 5-9. The exact location of the leach field is not known but is expected to be about 20 feet southeast of the trailer site. The trailer has been moved, exposing the end of the PVC drain line leading to the leach field. The leach field is expected to be located by excavating along the drain line. The sample will be taken at the most highly contaminated location, based upon field screening data, visual observations, and other information. If no evidence of contamination is observed, the sample will be taken immediately beneath the end of the drain line.

Quality assurance samples will be taken in accordance with the requirements of the QAPjP in Annex II. The types of quality assurance samples and the minimum numbers of samples are summarized in Table 5-16. The sampling locations for the quality assurance samples will be determined by the Field Team Leader based on the criteria presented in Chapter 4.

TABLE 5-16

Group 4 Sampling Types

Medium	Number of Site Samples	Expected Number of QA Samples[a]	Total Samples
Leach Field Soil			
Soil—field XRF	5	1	6
Soil—laboratory	2	3	5

Field blank: The greater of one in 20 samples or one per sampling round
[a] Duplicate Sample: The greater of one in 20 samples or one per sampling round. Note that all field XRF QA samples are duplicate samples.
Equipment (Rinsate) Blank: The greater of one in 20 samples or one per sampling round.

All information pertinent to the sampling activity will be documented in the field log as specified in Section 4.3.7. All sampling sites will be marked for later geodetic surveying. The sampling procedures are listed in Table 5-17 and are drawn from the generic lists presented in Annex II. Health and safety procedures for field activities are listed in Annex II and should be reviewed prior to any sampling activity.

TABLE 5-17

Group 4 Sampling Procedures

Activity	Procedure
General Sampling Instructions	See Annex II
Field Health and Safety	See Annex II
Sampling for Volatile Organics	LANL-ER-SOP-6.03
Spade and Scoop Method for Collection of Soil Samples	LANL-ER-SOP-6.09
Hand Auger and Thin-Wall Tube Sampler	LANL-ER-SOP-6.10
Stainless Steel Surface Soil Sampler	LANL-ER-SOP-6.11

5.5 GROUP 5: CONTAINER STORAGE FACILITY

The container storage facility in Building TA-57-56 (PRS 57-003) contains a temporary storage section for materials regulated under RCRA and another section for fuel oils, lubricating oils, and other substances not regulated under RCRA. The building is a three-sided metal structure approximately 10 ft by 40 ft in plan, and 10-ft high. It rests on a concrete slab with raised edges to contain liquid spills. The location of this building is shown in Figure 5-1.

No further action will be taken regarding the temporary storage portion of the building because it is managed under the Laboratory's hazardous waste generator requirement. This is further discussed in Section 6.2.4. Although minor lubricating oil stains have been observed on the soil beside the building, no significant spills of materials stored in the building are known to have occurred. The current risk associated with the oil stains is considered to be acceptably small given the controlled access and industrial use of the site, and environmental characterization will be deferred to D&D for the other section of the building.

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6.0 RECOMMENDATIONS FOR NO FURTHER ACTION

6.1 Introduction

This chapter presents information on PRSs that are proposed for no further action. The PRSs described in Section 6.2 are considered suitable for unrestricted use based on archival information and application of one or more of the four NFA criteria presented below. These NFA criteria are based on criteria in proposed Subpart S and the 23 May 1990 HSWA Module of the Laboratory RCRA permit (EPA 1989, 0088). Table 6-1 lists all PRSs in OU 1154 that are proposed for no further action.

TABLE 6-1

PRSs in OU 1154 Proposed for No Further Action

PRS Number	PRS Name	NFA Criterion	Work Plan Section
57-001(a)	Drilling Mud Pits	2	6.2.1
57-003	Container Storage Area	3	6.2.4
57-005	Pond Filtration Unit	2	6.2.3

NFA Criterion 1. The PRS has never been used for the management (that is, generation, treatment, storage, or disposal) of RCRA solid or hazardous wastes, radionuclides, or other CERCLA hazardous substances.

Units falling under Criterion 1 may, for example, have been mistakenly identified in an earlier study. Upon review of available information, no evidence of a release is found. The unit will not be investigated if there has been no release of hazardous wastes or constituents.

Some non-RCRA-regulated constituents, such as radionuclides, may be addressed in the work plan and investigated, as appropriate, either as a result of potentially being present at a PRS as the result of internal DOE requirements, or because it is within the scope of CERCLA.

NFA Criterion 2. Site design, conditions, or institutional controls prohibit releases from the PRS that would pose a threat to human health or the environment.

Release of any hazardous constituents may also be unlikely due to engineering (such as secondary containment or overflow prevention) or management (such as inspection or inventory) controls. Impacts to human health (excluding on-site workers) or the environment (outside of a building or other containment) would not be discernible above background levels for potential contaminants.

NFA Criterion 3. The PRS is part of a process operating under the Laboratory's current RCRA Part B permit, NPDES, or other applicable discharge permit. Potential release sites that fall under other regulatory programs may be exempt from further action under RCRA corrective action but may undergo corrective action under CERCLA.

Non land-based RCRA TSD facilities (such as containers or tanks) are generally not considered under RCRA corrective action, because requirements under interim status and RCRA permits will adequately address releases from these units.

Temporary storage areas (less than 90 days and satellite storage areas) are regulated by generator requirements. To avoid further consideration, engineering and management controls must be applied. If there is evidence of a possible release, whether visual staining, vapor releases, or analytical data indicating a release has occurred (and remediation has not been accomplished), and if the unit qualifies under the HSWA Module or under CERCLA, it may undergo corrective action measures under the ER Program.

Potentially contaminated sediments downstream of a surface water outfall are subject to consideration for corrective action, and attention should be focused on the impacts of potential contaminants in the sediment as a source of release, not the water. If a PRS is not vegetated or covered, windblown dust will be a concern under RCRA, and further investigation may be necessary.

Releases to groundwater from land-based RCRA TSD units should be addressed under RCRA detection and compliance monitoring programs. However, under HSWA corrective action, EPA can address releases from PRS to other media, such as soil, air, or surface water. Even though it may be more expedient and convenient to address release pathways under corrective action, the State of New Mexico will ultimately have to approve the closure plan for the regulated unit. The EPA can also require corrective action beyond closure, if warranted.

NFA Criterion 4. The PRS has been characterized or remediated in accordance with current applicable state or federal regulations, and the available data indicate that contaminants of concern are either not present or are present in concentrations near background levels.

Cleanups under other regulatory programs, if essentially remediated to approximate background, should not be re-evaluated under corrective action. Groundwater and soil cleanups, if successful so that no significant impact can be detected, need not be re-evaluated. If cleanup is in progress, no additional evaluation is necessary if done under regulatory agency approval and the cleanup levels are comparable to those under RCRA.

A one-time spill of raw material would not normally result in a release that is to be considered under RCRA corrective action. The RCRA process is specifically concerned with routine and systematic releases of hazardous wastes and constituents. However, unless there is documentation that the spill was cleaned up to levels that would be acceptable under RCRA or other applicable standards, the possible area of impact may be an area of concern (AOC) and would remain under consideration in this work plan. In addition, possible future releases are not to be considered under RCRA corrective action. The RCRA corrective action program is not a spill prevention program and should focus on past or continuing releases. Voluntary corrective action measures will reduce the time and cost required to cleanup many PRSs. If a release has occurred and it will eventually be cleaned up, it can be addressed voluntarily, and the work plan can be implemented to show that the PRS is clean.

6.2 POTENTIAL RELEASE SITES RECOMMENDED FOR NO FURTHER ACTION

The PRSs recommended for NFA are the drilling mud pits in Group 1, one facility associated with the pond system in Group 2, and the RCRA-regulated storage unit in Group 5.

6.2.1 Group 1: Drilling Mud Pits—PRS 57-001(a)

Description and History

Drilling was conducted at Fenton Hill under the supervision of the New Mexico Division of Oil and Gas. Deep well GT-1 was drilled in Barley Canyon, and deep wells GT-2, EE-1, EE-2, and EE-3 were drilled at site TA-57. Wells EE-2 and EE-3 were redrilled with deviated holes departing at an angle from the original hole. The additional subsurface segments were referred to as EE-2A and EE-3A. Redrilling requires that a rig reoccupy the surface site and generally involves surface facilities similar to those used in the original drilling.

At Fenton Hill, the drilling muds were circulated through the drill string while drilling was in progress. The drilling muds served two purposes: the heavy mud stabilizes the wellbore against mechanical failure, and the mud lubricates the bit and drill string, particularly in deviated holes where the tools tend to get stuck. Because barites were the predominant weighting material, the muds had high concentrations of barium. Also, the predominant lubricating materials were detergents, such as "Coat 415," which were present in the mud in high concentrations.

Drilling pits and tanks were used to store drilling fluids to keep the pumps supplied. At Fenton Hill, the records are insufficient to determine whether or not a separate pit was dug for each of the five drilling operations (GT-1, GT-2, EE-1, EE-2, EE-3) or the two re-drilling operations (EE-2A and EE-3A). However, a pit, if used, would be as close as operationally possible to the rig and would have to have been within 50 ft of the well collar. Based on this reasoning, the mud pits would have been within the dashed 50-ft radius circles drawn about each well site in Figure 6-1.

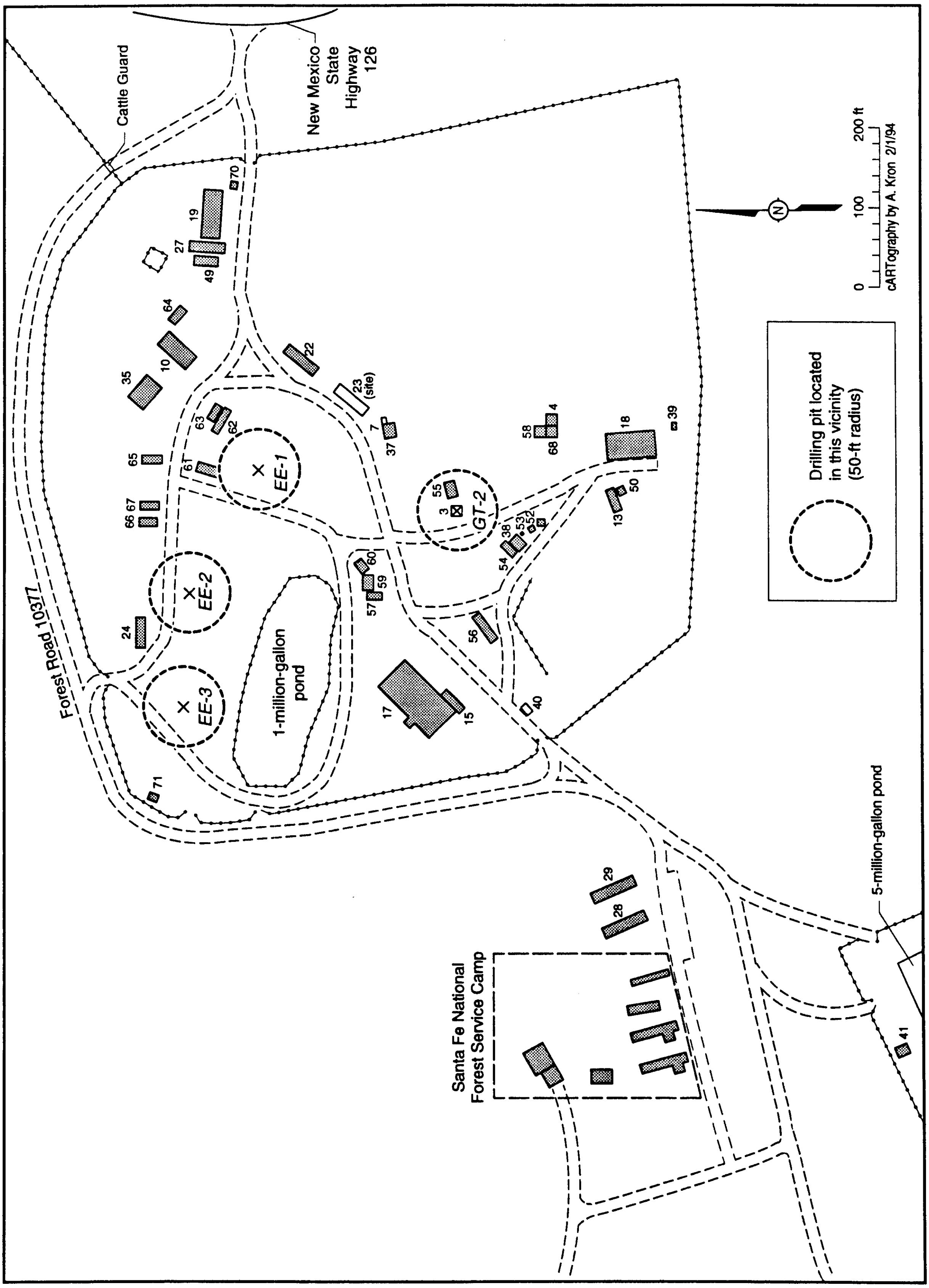

Figure 6-1. Potential locations for the drilling mud pits at each of the wellbores.

At Fenton Hill, the usual practice was for the facility manager to dig the pits for the driller with a bulldozer. The dirt would be stockpiled while drilling was in progress. On completion of drilling, the water in the pit would be pumped out to the settling pond; any remaining mud would be excavated until the hole was visually clean; and the pit would be backfilled with clean soil. Potential contaminants included detergents used in the drilling operation, barite-bentonite mud, and possibly small areas (above water line) of diesel oil stains from the pump machinery. The excavated drilling mud was disposed off-site at the sludge pit, which is being investigated in Phase I (See Section 5.3).

The construction as well as the subsequent removal and restoration of a drilling mud pit are regarded as part of the drilling operation and are subject to regulation by the New Mexico Division of Oil and Gas (NMDOG). A telephone call to NMDOG September 16, 1993, confirmed that NMDOG has no concerns regarding the drilling operations or the subsequent restoration of the pits at Fenton Hill (Burns 1993, 24-0049).

Basis for Recommending No Further Action

Potential Release Site 57-001(a), the drilling mud pits, is recommended for NFA under Criterion 2. Comprehensive lists of the muds and mud additives used in drilling at Fenton Hill were prepared by Bob Hendron, the Laboratory Fenton Hill Project Manager (Burns 1993, 24-0070; Burns 1993, 24-0078). The material safety data sheets (MSDSs) for every potentially hazardous substance on these lists were reviewed. The results of this review are summarized on Table 6-2.

Many of the muds and mud additives were found to contain no hazardous constituents. Others were found to have been used in minimal quantities. Some contained acids or bases that would have been neutralized during use or during subsequent exposure to natural environmental conditions. Although barium was used extensively, it was in the form of barium sulfate, which is not soluble in water and would have remained in the mud that was later removed to the sludge pit (PRS 57-002). Water-soluble constituents would also have largely been retained in the clay structure of the bentonite muds and would have also been removed to the sludge pit. Such constituents were used to control the properties of the mud; they would not have been used in quantities that would have exceeded the capability of the mud to retain them, and no significant quantities are

TABLE 6-2

Drilling Mud MSDS Review Summary

Material	Estimated Usage[a] (lb)	Review Comments
Aldacide	975	Para-formaldehyde—volatile and soluble in water; used only in small quantities as biocide
Aluminum stearate	585	No hazardous components—fatty acids
Aquagel	780,000	No hazardous components—bentonite
Barafloc	120	No hazardous components—organic polymer
Barafos	975	Meta-phosphoric acid—reactivity neutralized during drilling process
Baroid	650,000	Barium sulfate—not soluble in water, most likely ended up in muds removed to sludge pit
Ben-ex	2,730	Vinyl acetate—tied up in maleic anhydride copolymer
Bentonite	3,900	No hazardous components
Bicarbonate of soda	15,000	No hazardous components
Big cat	5,600 gal	No hazardous components —detergent
Carbonox	19,500	No hazardous components—lignite
Caustic soda	210,000	Sodium hydroxide—activity neutralized during drilling process
Coat 415	214	Organic solvents and salts—low volume used and material should adsorb on clay particles; most likely ended up in muds removed to sludge pit

TABLE 6-2 (Continued)

Drilling Mud MSDS Review Summary

Material	Estimated Usage[a](lb)	Review Comments
Coat 777	40,000	Ammonium bisulfite—not regulated, majority of the material most likely ended up in muds removed to sludge pit
Coat 777 catalyst	175	No hazardous components—low volume used
Cotton seed hulls	190,000	No hazardous components
EP Mud lube	156	Sulfurized crude tall oil mixture—low volume used and material is not regulated—tall oil is a by-product from wood processing
Kwik seal	40,000	None—no hazardous components -vegetable and polymer fibers
Lime	71,000	Calcium hydroxide—material will have reacted with acids used to provide a neutral material
Lo Sol	1,500	No hazardous components—anionic polymer
MF-1	2,800	No hazardous components—polyacrylamide
Mud gel	1,500,000	No hazardous components—bentonite
Multi-seal	7,000	No hazardous components—blended fibrous materials
Salt	10,000	No hazardous components
Sawdust	88,000	No hazardous components
Selec-floc	940	No hazardous components

TABLE 6-2 (Continued)

Drilling Mud MSDS Review Summary

Material	Estimated Usage[a] (lb)	Review Comments
Soda ash	38,000	No hazardous components - sodium carbonate
Sulfuric acid	2,000 gal	H_2SO_4—activity neutralized during drilling process
Surflo H-35	3,900 gal	Phosphate descaler -material most likely ended up in muds removed to sludge pit
Torq-Trim II	1,000 gal	Isopropyl alcohol (30%)—not listed as hazardous under RCRA —most likely ended up in muds removed to sludge pit
Trimuslo	58 gal	Petroleum solvent—small volume, should be removed with the sludge from the settling ponds
Walnut hulls	88,000	No hazardous components

a Estimated by LANL Fenton Hill Project Manager Bob Hendron, based on detailed product use information for Borehole EE-2 and extended to other holes on basis of hole depths (Burns 1993, 24-0070; Burns 1993, 24-0078).

therefore expected to have been lost to the underlying soil. No hazardous constituents were identified that would have remained at the site in significant quantities after cleanup.

None of the drilling mud pits remain. They have been cleaned to meet New Mexico Division of Oil and Gas closure standards and have been filled with clean soil (Burns 1993, 24-0070; Burns 1993, 24-0078). Any hazardous constituents would have remained with the mud, and the cleaned pits pose no threat to human health or the environment.

6.2.2 Group 2: Pond Filtration Unit—PRS 57-005

Description and History

The settling pond filtration unit was a system of pipes and filter units designed to remove particulates from the pond water. The unit was placed to the east of pond GTP-1 and consisted of two approximately 10-ft high above-ground tanks filled with various grades of sand. The pond water was filtered through the sand to remove most of the particulates and then flowed through charcoal-containing canisters to remove the finer particles. The filtered water was discharged either to pond GTP-3W where it seeped into the ground, evaporated, or eventually was released into Burns Swale, or was discharged to the EPA-permitted outfall 001 001 where it then flowed into Burns Swale. The sand and charcoal material was periodically cleaned out of the tanks and canisters by backwashing into the GTP-1 pond. As was mentioned previously, the sludge from the pond was taken to the sludge pit, which will be investigated under this work plan. The filtration unit was taken out of service in 1989 or 1990, and is inactive. It is currently stored on the northwest side of pond GTP-1. A visual inspection of the unit in October 1993 showed no signs of leakage or deterioration.

Basis for Recommending No Further Action

The pond filtration unit is recommended for NFA under Criterion 2. It was located on the ground surface, and its components were readily visible for inspection. No significant leaks were documented during the period that it was in service, and there is no evidence of any releases of hazardous materials to the environment. Any particulates accumulated on the filters were periodically backwashed into the GTP-1 pond and ultimately disposed of at the sludge pit. The unit is no longer being used. It does not pose a threat to human health or the environment; nor has it posed a threat in the past.

6.2.4 Group 5: Container Storage Facility—PRS 57-003

Description and History

The container storage facility is described in Section 5.5. As previously described, the storage area is divided into a temporary storage section, which is managed under the Laboratory's hazardous waste generator requirements, and another section that is not managed under these requirements. Only the part of the storage area operated under the generator requirements is being recommended for NFA. Sampling of the other part is being deferred to D&D, as discussed in Section 5.5.

Basis for Recommending No Further Action

The managed part of the container storage area is recommended for NFA under Criterion 3. The area is managed under the Laboratory's hazardous waste generator requirements and is being monitored under those requirements.

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Annex I

Project Management Plan

1.0 INTRODUCTION

This annex presents the technical approach, schedule, reporting milestones, budget, and management structure for implementation of the RCRA Facility Investigation (RFI) for Operable Unit (OU) 1154. This project management plan is an extension of the Los Alamos National Laboratory (the Laboratory) Environmental Restoration (ER) Program Management Plan described in Annex I of the Installation Work Plan (IWP) (LANL 1993, 1017). It contains no significant departures from IWP guidelines. This annex discusses the elements required of project management plans set forth in Module VIII (the HSWA Module) of the Laboratory's RCRA permit (EPA 1990, 0306) as they apply to OU 1154. Figure 1-1 (in Chapter 1) locates the OU, and Table 4-1 provides a list of the types of potential release sites (PRSs) addressed by this work plan.

2.0 TECHNICAL APPROACH

The approach used for OU 1154 is based on the ER Program's overall technical approach to the RFI/CMS process as described in Chapter 3 of the IWP (LANL 1993, 1017). The following key features characterize the ER Program approach:

- use of guidelines for cleanup derived from health-based risk assessments using realistic but conservative exposure scenarios;
- a phased approach to site assessment;
- application of the "observational" approach to the RFI/CMS process as a general philosophical framework.

The technical approach employed for the OU 1154 RFI is described in Chapter 4 of this work plan. Figure 4-1 in Chapter 4 presents a logic diagram for OU 1154 RFI investigations.

The technical objectives of the OU 1154 RFI are as follows:

- for those PRSs not proposed for no further action (NFA) and not eligible for deferred action (DA), identify contaminants potentially present at each PRS;

- conduct sampling to confirm the presence of contaminants of concern (COCs);
- if COCs are present, determine the vertical and lateral extent of the contamination at each PRS; or if immediate action is required, the corrective action is obvious and does not require further study, and the action can be accomplished in an efficient and cost-effective manner, recommend a VCA.
- identify contaminant migration pathways;
- acquire sufficient information to allow quantitative migration pathway modeling and site specific risk assessment;
- provide data necessary for the assessment of potential remedial alternatives; and
- provide the basis for detailed planning of corrective measures studies (CMSs) or, if immediate action is required, the corrective action is obvious and does not require further study, and the action can be accomplished in an efficient and cost-effective manner, recommend a VCA.

The approach to investigations at OU 1154 started with activities necessary to write this work plan. The PRSs identified in the SWMU Report (LANL 1990, 0145) were located and visited in the field, and a preliminary investigation was conducted at the OU to determine its physical and ecological nature. An archival record was developed for each PRS based on Laboratory records, on-site observations, and interviews with cognizant Laboratory and contractor staff.

Based on these investigations, PRSs were combined into five groups based on facility type and similarity of expected investigation and corrective actions. For example, settling ponds were combined because of the similarity of the facilities and the expected investigation.

Important to project management is the phased approach adopted for the OU 1154 RFI activities. This approach sets up a series of decision points (see Figure 4-1 in

Chapter 4) that require the design of specific investigations at each stage. These investigations develop adequate information on which to base decisions. The investigations include provisions to remove PRSs from further consideration or to initiate interim action at each stage of the investigation as information becomes available. The approach incorporates the concepts for reducing uncertainty due to sampling and analysis presented in Appendix H of the IWP (LANL 1993, 1017). This process has already identified OU 1154 PRSs as candidates for no further action or as appropriate for deferred action under other Laboratory programs (Chapters 5 and 6 of this work plan).

3.0 SCHEDULE

General schedule requirements for the Laboratory's ER program are described in Annex I (Program Management Plan) of the IWP. Appendix O of the IWP contains a project RFI/CMS schedule for the RFI/CMS process for OU 1154, through the completion of the final CMS report. A revised version of this schedule has been completed for Activity Data Sheet (ADS) 1154 for incorporation in the DOE Environmental Restoration and Waste Management Five-Year Plan. This plan is a key budget planning document for the DOE-wide ER Program. The projected RFI schedule, milestone schedule, and baseline (unconstrained) budget summary submitted to DOE for OU 1154 are provided in Figure ES-1 and in Table ES-1 in the Executive Summary of the OU 1154 RFI Work Plan.

Implementation of RFI activities is contingent upon regulatory review and approval of the OU 1154 RFI Work Plan and upon the availability of funding. If the detailed costing of this OU work plan exceeds the planned budget, budgetary resolution will be accomplished either by a petition to DOE for additional funding through a change-control procedure or by extension of the RFI schedule. Schedules and costs will be updated through the DOE change control process as appropriate, with revisions submitted to EPA for approval. The assumptions used to generate this schedule include the following:

- The schedule assumes that an adequate number of support personnel (e.g., health and safety technicians and trained drilling contractors) will be available.

- EPA approval, if required, of work plan modifications (including EPA comments, Laboratory revision, and final EPA approval) is assumed to take two months, of which one month is allowed for EPA review and comment and one month for revisions.

- Phase II investigations are expected to be required only at a limited number of PRSs, if any.

- The Phase I work scheduled in the first investigation year (1994) is constrained by the current planned DOE budget.

- Where possible, extensive field work will not be scheduled between November 15 and March 15 each year, to allow for inclement weather.

4.0 REPORTING

Results of RFI field work will be presented in three principal documents: technical progress reports, phase reports, and the RFI report. The purpose of these reports is detailed in the following discussion. A schedule of future documents associated with implementation of this OU work plan, which are deliverables to EPA and DOE, is summarized in the following list.

Document	EPA	DOE	Date Due
Monthly	x	x	25th of the following month
Quarterly	x		Feb. 14, May 15, & August 15
Annual	x	x	November 15
Phase Reports	x	x	As in baseline; EPA milestones

4.1 Technical Progress Reports

As the OU 1154 RFI is implemented, technical progress will be summarized in technical progress reports, as described in the HSWA Module. Detailed technical assessments will be provided in phase reports.

4.2 Phase Reports

Phase reports will be submitted for work conducted on OU 1154 PRSs. These documents will function as interim reports on portions of the RFI effort because of the multiyear time-frame that will be required for completion of RFI field work. They will summarize the results of initial site characterization activities and describe the follow-on activities being planned including any modifications to field sampling plans suggested by initial findings and any Phase II work.

4.3 RFI Report

The RFI report for OU 1154 will summarize all field work conducted during the RFI. As stated in Chapter 3 of the IWP (LANL 1993, 1017), the RFI report will describe the procedures, methods, and results of field investigations and will include information on the type and extent of contamination, sources and migration pathways, and actual and potential receptors. The report also will contain adequate information to support delisting of sites that require no further corrective action.

5.0 BUDGET

The current schedule for ADS 1154 is based on a constrained budget for the first years of the RFI and a preliminary cost analysis that is subject to significant uncertainties. The projected budget in FY 95 is based on expected DOE funding levels and is subject to change depending upon actual funding allocations. A change control petition to DOE is required to augment these funding levels. Because DOE funding requests are set two years in advance, the first year in which the OU 1154 RFI is not constrained by previous budget estimates will be FY 96. Funding requests for FY 96 and beyond will reflect the cost and schedule that most efficiently complete the RFI plans.

The RFI costing is being refined and is subject to considerable uncertainties at the present time. In particular, uncertainties regarding the cost of drilling through potentially contaminated areas could impact RFI costs substantially and thus potentially affect the RFI schedule.

6.0 PROJECT ORGANIZATION AND RESPONSIBILITY

The organizational structure for the ER Program is presented in Chapter 3 of the IWP (LANL 1993, 1017) and in Figure I-1 as applied to OU 1154. The ER Program lines of authority and responsibilities are identified in those figures. The responsibilities of the Technical Team Leaders are as described in the IWP. They are identified in Figure I-1 to show lines of authority.

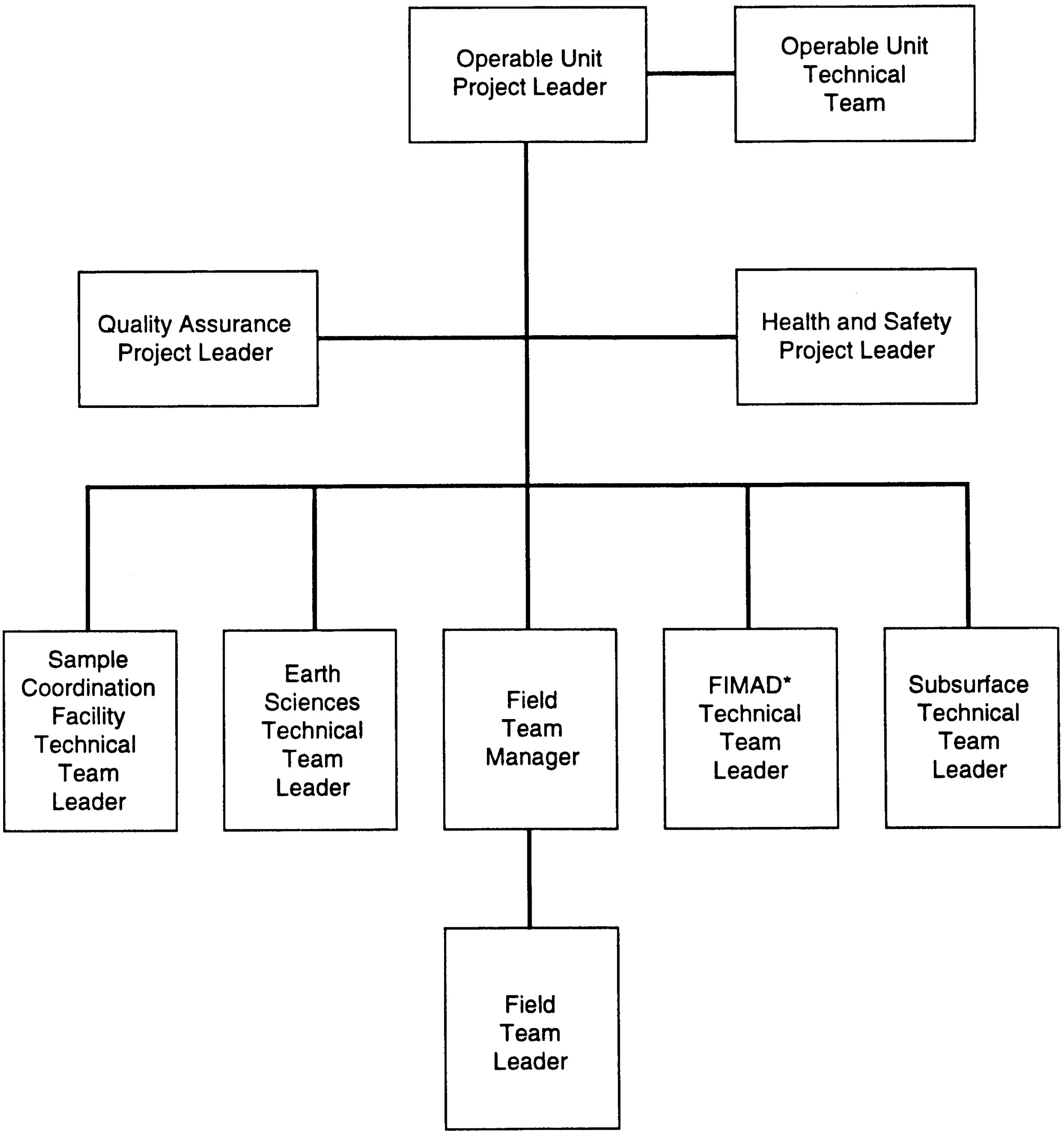
Records of qualifications and training of all field personnel working on the RFI for OU 1154 will be kept as ER Records (see Annex IV of the IWP, Records Management Plan). Technical contributors to the OU 1154 work plan are listed in Appendix A of this OU work plan.

The responsibilities of the Operable Unit positions identified in Figure I-1 are summarized in the following subsections.

6.1 OU Project Leader

Responsibilities of the OU 1154 Project Leader are as follows:

- oversees day-to-day RFI operations, including planning, scheduling, and reporting of technical and administrative activities;
- ensures preparation of scientific investigation planning documents and procedures;
- prepares monthly and quarterly reports for the EPA, DOE and the ER Program Manager (PM);
- oversees subcontractors, as appropriate;



*FIMAD = Facility for Information Management and Display

Figure I-1. Organizational structure.

- coordinates with technical team leaders;
- conducts technical reviews of the milestones and final reports;
- interfaces with the ER Quality Program Project Leader (QPPL) to resolve quality concerns and to coordinate with the QA staff for audits;
- complies with LANL ER Program Health and Safety (HS), records management, and community relations requirements;
- oversees RFI field work and manages the field team leader; and
- complies with the Laboratory's technical and QA requirements for the LANL ER Program.

6.2 Technical Team Members

Technical team members are responsible for providing technical input for their disciplines throughout the RFI/CMS process. Technical team members have participated in the development of the OU 1154 work plan and the individual field sampling plans and will continue to participate in the field work, data analysis, report preparation, work plan modifications, and planning of subsequent investigations as necessary.

The primary disciplines currently represented on the OU 1154 technical team are chemistry, geology, hydrology, geochemistry, statistics, biology, safety, industrial hygiene, archaeology, and health physics. The composition of the technical team may change with time as the technical expertise needed to implement the OU 1154 RFI changes.

6.3 Field Team Manager

Responsibilities of the OU 1154 Field Team Manager include the following:

- conducts detailed planning and scheduling for the implementation of the RFI activities;
- coordinates field activities with the technical team leaders;
- oversees day-to-day field operations; and
- manages field team activities.

6.4 Field Team Leader

The Field Team Manager will assign field work to Field Team Leaders for implementation of the RFI in the field. Each Field Team Leader will direct the execution of field sampling activities, using crews of field team members as appropriate for the activity. Field Team Leaders may be Laboratory or contractor personnel.

6.5 Field Team Member(s)

Field Team Members may include the following, as appropriate:

- sampling personnel,
- site safety officer,
- geologists,
- hydrologists,

- health physicists, and
- representatives of other applicable disciplines.

All teams will have, at a minimum, a site safety officer and a qualified field sampler. They are responsible for conducting the work detailed in field sampling plans, under the direction of the field team leader. Field team members may be Laboratory or contractor personnel.

6.6 Other Project Participants

Other OU 1154 project participants include the Quality Assurance Project Leader, the Health and Safety Project Leader, and the Technical Team Leaders (TTLs). The Quality Assurance Project Leader provides surveillance oversight for the proper implementation of the OU 1154 QAPjP (Annex II). The Health and Safety Project Leader provides surveillance oversight for the proper implementation of the OU 1154 Health and Safety Palan (Annex III). The Sample Coordiantion Facility TTL provides laboratory analytical support for OU 1154 field samples. The Earth Sciences TTL provides geologicaal site characterization support, the FIMAD TTL provides data handliing support, and the Subsurface TTL provides drilling support for OU 1154.

REFERENCES

EPA (US Environmental Protection Agency), April 10, 1990. Module VIII of RCRA Permit No. NM0890010515, EPA Region VI, issued to Los Alamos National Laboratory, Los Alamos, New Mexico, effective May 23, 1990, EPA Region VI, Hazardous Waste Management Division, Dallas, Texas. (EPA 1990, 0306)

LANL (Los Alamos National Laboratory), November 1993. "Installation Work Plan for Environmental Restoration," Revision 3, Los Alamos National Laboratory Report LA-UR-93-3987, Los Alamos, New Mexico. (LANL 1993, 1017)

LANL (Los Alamos National Laboratory), November 1990. "Solid Waste Management Units Report," Volumes I through IV, Los Alamos National Laboratory Report No. LA-UR-90-3400, prepared by International Technology Corporation under Contract 9-XS8-0062R-1, Los Alamos, New Mexico. (LANL 1990, 0145)

Annex II

QAPjP

Executive Summary

Chapter 1
Introduction

Chapter 2
Background Information
for Operable Unit 1154

Chapter 3
Environmental Setting

Chapter 4
Technical Approach

Chapter 5
Potential Release Sites

Chapter 6
Recommendations for
No Further Action

Annexes

Appendices

1.0 PROJECT DESCRIPTION

This quality assurance (QA) project plan (QAPjP) provides specific instructions to Los Alamos National Laboratory (the Laboratory) and its contractors to help assure that the work performed during the Operable Unit (OU) 1154 Resource Conservation and Recovery Act (RCRA) Facility Investigation (RFI) will be of the quality required to satisfy project objectives.

1.1 Introduction

This plan addresses the 16 essential elements presented in the US Environmental Protection Agency (EPA) document "Interim Guidelines and Specifications for Preparing Quality Assurance Project Plans" (QAMS-005/80) (EPA 1980, 0552). This document is tiered to the Laboratory's Generic Quality Assurance Project Plan for RFIs (LANL 1991, 0412).

1.2 Facility Description

A facility description of LANL and descriptions of individual areas are presented in Section 2.0 of the LANL ER Program Installation Work Plan (IWP) (LANL 1993, 1017).

1.3 Environmental Restoration Program

A description of the ER Program is presented in Section 3.0 of the IWP (LANL 1993, 1017).

1.4 Project Description

Operable Unit 1154 incorporates Technical Area (TA) 57 and two additional areas, a sludge pit south east of TA-57 and a deep well drilling site north of TA-57. Research activities have been conducted within OU 1154 since 1974 primarily in the areas of thermal energy development. Specific past and present activities conducted at each of the sites are discussed in more detail in Chapters 2 and 5 of this OU 1154 RFI work plan.

Preliminary investigations of the OU revealed 16 PRSs that warranted more detailed investigation. These PRSs are decommissioned mud pits used during drilling, active and inactive settling ponds, an inactive sludge pit, an inactive waste tank and the leach field formerly serving the chemistry trailer, and a chemical storage area. More complete descriptions of OU 1154 are included in this RFI work plan.

1.4.1 Project Objectives

The comprehensive project objectives are described in Chapter 4 of the OU 1154 RFI Work Plan. Specific project objectives for each group of sites to be investigated are presented in Chapter 5 of the work plan.

1.4.2 Project Schedule

The anticipated project schedule is provided in the Executive Summary of the work plan.

1.4.3 Project Scope

The scope of the OU 1154 RFI is given in Chapter 4 of the work plan.

1.4.4 Background Information

The background information is given in Chapter 2, and the environmental setting is given in Chapter 3 of the work plan.

1.4.5 Intended Data Uses

The intended data uses are described in Chapters 4 and 5 of the work plan.

2.0 PROJECT ORGANIZATION AND RESPONSIBILITY

The overall organizational structure of the Environmental Restoration (ER) Program is presented in Section 2 of the LANL QPP (Annex II of the IWP) (LANL 1993, 1017). The organizational structure of the OU 1154 work activities is summarized in Figure I-1 in Annex I of this work plan. A complete description of the responsibilities under this organizational structure can also be found in Annex I. Primary project assignments and telephone contact numbers are as follows:

- Operable Unit Project Leader (OUPL): Tracy Glatzmaier, (505) 665-2613
- Quality Program Project Leader (QPPL): Larry Souza , (505) 665-0470
- Health and Safety Technical Leader (HSPL): Susan Alexander, (505) 667-5722 or (505) 104-3283
- Field Team Leader (FTL): To be determined
- Earth Sciences (ES) Technical Team Leader (TTL): Jamie Gardner, (505) 667-1799
- Sample Coordination Facility (SCF) TTL: John Miglio, (505) 665-8742
- Subsurface Studies (SS) TTL: Sue Goff, (505) 667-7200
- Facility for Information Management, Analysis, and Display (FIMAD) TTL: Nancy Marusak, (505) 667-5698

The QA responsibilities of OU 1154 project team members are described in the following subsections. Brief descriptions of the education and relevant experience of the OU 1154 RFI personnel are provided in Appendix A of this work plan. The responsibilities described for each team member can be delegated by that team member to other qualified individuals as required to meet project demands.

2.1 Operable Unit Project Leader

The responsibilities of the OUPL for OU 1154 are described in Annex I. The OUPL will assign work for the OU 1154 RFI through the use of specific written scopes of work for both subcontractors and internal Laboratory personnel and groups. The assignment of work to subcontractors will be controlled through the procurement processes of the Laboratory's Materials Management (MAT) Division. The assignment of work within LANL will be controlled though the use of internal statements of work (SOWs). Section I of the SOW provides a task and budget summary for the assigned work. Section II of the SOW includes the responsibility and description summary.

As required by internal SOW procedures, internal work will only be assigned after a completed SOW is provided either by or to the OUPL in response to the detailed scope of work. Section II of the SOW provides documentation of responsibilities for the OU 1154 RFI activities. Copies of the completed SOW will be provided to the OUPL, and Section II of the SOW will be provided to the people to which the work has been assigned. If any additional personnel are assigned after the SOW has been completed, Section II of the SOW must be completed for each additional person.

2.2 Quality Program Project Leader

The QPPL functions independently from the OU 1154 project. The QPPL reports directly to the ER Program Manager on day-to-day activities when necessary to resolve QA issues.

The QPPL in support of OU 1154:

- ensures that the quality program is properly implemented;
- ensures that independent organizations adequately and effectively evaluate the quality program;
- verifies that ER Program personnel and subcontractors properly implement the ER Quality Program;

- oversees the OU 1154 QA staff;
- resolves disputes and issues stop-work orders regarding quality;
- reviews and approves quality-related plans and implementing procedures;
- conducts QA audits, reviews, and surveillance;
- coordinates QA audits with the OUPL; and
- prepares monthly QA reports to the ER Program Manager.

2.3 Health and Safety Project Leader

The responsibilities of the HSPL for OU 1154 are described in detail in Annex III, the OU 1154 Health and Safety Plan.

2.4 Field Team Leader

The responsibilities of the FTL for OU 1154 are described in Annex I.

2.5 Technical Team Leaders

The TTLs for OU 1154:

- provide technical support for team activities under the coordination of the FTL, OUPL, QPPL, and HSPL;
- issue programmatic and technical guidance to field team members;
- review the quality and completeness of team deliverables;
- ensure the development of Standard Operating Procedures (SOPs), as appropriate; and

- designate appropriate QA representatives.

The TTLs for OU 1154 may delegate any of their responsibilities to their staff personnel as needed to meet the project schedule and QA requirements. The OU 1154 Phase I activities are anticipated to require the services of the ES, SCF, and SS TTLs. Additional TTLs may be added to the project as needed.

2.6 Field Team Supervisor

The responsibilities for the Field Team Supervisors for OU 1154 are described in Annex I.

2.7 Field Team Members

The field team members will include, depending on the activity being conducted, a site safety officer, appropriate subcontractors, sampling personnel, and staff members with technical knowledge of geology, hydrology, statistics, chemistry, and other applicable disciplines. The field team members comply with the ER Program's technical, administrative, and QA procedures as described in this QAPjP and with the TTLs, FTL, and OUPL.

3.0 QUALITY ASSURANCE OBJECTIVES FOR MEASUREMENT DATA

The QA objectives for measurement data are expressed in terms of the precision, accuracy, representativeness, completeness, and comparability of the data. The precision, accuracy, and completeness objectives for the OU 1154 RFI are based on the criteria specified in Chapter 5 of the Generic QAPjP. The analytical methods that will be used for the OU 1154 analyses are based on EPA methods, or equivalent when available, or the methods of generally recognized and accepted institutions such as the American Public Health Association or American Society for Testing and Materials.

The overall QA objective is to develop and implement procedures that will help ensure quality in field sampling, field testing, chain-of-custody, laboratory analysis, data validation, data analysis, and data reporting. Specific procedures for sampling, chain-of-custody, audits, preventive maintenance, and corrective action are described in other sections of this QAPjP or in specific procedures referenced by this QAPjP. This section defines the goals for accuracy, precision, completeness, representativeness, and comparability. Quality Assurance goals for field measurements are also discussed.

3.1 Level of Quality Control

The levels of quality control (QC) described in Section 5.1 and Tables V.1 and V.2 of the Generic QAPjP will be used for the OU 1154 RFI with the following two exceptions. The first exception is that field reagent blanks will not be collected as field QC samples. The use of reagents in the field will be limited to preservation reagents that will also be added to the rinsate blanks and the Data Quality Objectives (DQOs) for the OU 1154 RFI can be met without the use of reagent blanks. The second exception is that the level of QC described in Table II-1 will be used for the field x-ray fluorescence (XRF) analyses.

3.2 Precision, Accuracy, and Sensitivity of Analyses

The precision, accuracy, and sensitivity of the laboratory analytical data will meet or exceed the limits provided in Table II-2 for each analyte included in the OU 1154 RFI. The sensitivity requirements provided in the Generic QAPjP have been changed for selected OU 1154 RFI analytes in order to address the screening action levels specified in Appendix J of the IWP (LANL 1993, 1017). The screening action levels for each analyte included in the OU 1154 RFI are also listed in Table II-2 of this QAPjP along with the required analytical methods for the OU 1154 RFI analyses. In addition, specific sensitivity requirements have been selected to allow the use of field XRF analysis. The XRF sensitivity limits do not allow for direct comparison to SALs in every case. This is acceptable with respect to project sensitivity requirements since the field XRF analyses will only be used to the horizons with the highest constituent levels for subsequent laboratory analysis.

3.3 Quality Assurance Objectives for Precision

The QA objectives for precision for the OU 1154 RFI analyses are listed in Table II-2. These limits are derived from the SW-846 (EPA 1989, 0518) methods described in the Generic QAPjP or from the SRP Field method SOP listed in Table II-3. The most recent revision of a procedure should be used, and new procedures may be used as appropriate.

TABLE II-1

XRF Field Sampling and Laboratory QC

Sample Type	Applicable Matrix	Sample Frequency
Field Replicate	Soil	1 per 10 samples
Field Reference Sample	Soil	1 per day
Quartz Blank	Soil	1 per day or every 20 samples, whichever is greater
Quality Control Reference Samples	Soil	2 per batch or every 20 samples, whichever is greater
Analytical Duplicate Sample	Soil	1 per 10 samples

TABLE II-2

Operable Unit 1154 RFI Sampling Parameters

Contaminant	Present Screening Action Level[a]	Practical Quantitation Limit mg/kg	Analytical Method[b]	Accuracy (%)	Relative Percent Difference[b] (%)
Organic Parameters					
Volatiles					
Acetone	8000	0.10	8260	±20	±20
Acetonitrile	TBD	0.10	8260	±20	±20
Benzene	0.67	9.0E-5	8260	±20	±20
Bromoform	89	0.005	8260	±20	±20
Carbon disulfide	7.4	0.10	8260	±20	±20
Carbon tetrachloride	0.21	1.0E-4	8260	±20	±20
Chloroform	0.21	2.0E-4	8260	±20	±20
2-Hexanone	TBD	0.05	8260	±20	±20
Isobutyl alcohol	TBD	0.10	8260	±20	±20
Methylene chloride	5.6	.01	8260	±20	±20
Methyl ethyl ketone	4000	0.1	8260	±20	±20
4-Methyl-2-pentanone	510	.05	8260	±20	±20
Pyridine	TBD	.005	8260	±20	±20
Tetrachloro[illegible]	5.9	4.0E-4	8260	±20	±20

Contaminant	Present Screening Action Level[a]	Practical Quantitation Limit mg/kg	Analytical Method[b]	Accuracy (%)	Relative Percent Difference[b] (%)
Toluene	890	0.005	8260	±20	±20
Trichlorethene	3.2	2.0E-4	8260	±20	±20
Tricholorofluoromethane	TBD	3.0E-4	8260	±20	±20
Vinyl acetate	TBD	0.05	8260	±20	±20
Vinyl chloride	0.013	4.0E-4	8260	±20	±20
Xylenes (total)	1.6E+5	.005	8260	±20	±20
Semi-Volatiles					
Acetophenone	TBD	NA	8270	±20	±20
Anthracene	24000	0.66	8270	±20	±20
Benzyl alcohol	TBD	1.30	8270	±20	±20
o-Cresol	4000	NA	8270	±20	±20
m-Cresol	4000	NA	8270	±20	±20
p-Cresol	4000	NA	8270	±20	±20
Dibenzofuran	TBD	0.66	8270	±20	±20
Diethyl phthalate	6.4E+4	0.66	8270	±20	±20
2,4-Dimethylphenol	1600	0.66	8270	±20	±20
Dimethyl phthalate	8.0E+4	0.66	8270	±20	±20
4,6-Dinitro-o-cresol	TBD	3.3	8270	±20	±20
2,4-Dinitrophenol	200	3.30	8270	±20	±20
2,4-Dinitrotoluene	1.0	0.66	8270	±20	±20
Di-n-octyl phthalate	1600	0.66	8270	±20	±20
Fluoranthene	3200	0.66	8270	±20	±20
Naphthalene	3200	0.66	8270	±20	±20
1-Naphthylamine	TBD	0.66	8270	±20	±20
2-Naphthylamine	TBD	0.66	8270	±20	±20
o-Nitroaniline	4.8	3.30	8270	±20	±20
m-Nitroaniline	TBD	3.30	8270	±20	±20
p-Nitroaniline	TBD	1.3	8270	±20	±20
Nitrobenzene	5.3	0.66	8270	±20	±20
o-Nitrophenol	TBD	0.66	8270	±20	±20
p-Nitrophenol	TBD	3.30	8270	±20	±20
Phenol	48000	0.66	8270	±20	±20
p-Phenylenediamine	TBD	0.66	8270	±20	±20
Inorganic Parameters - Laboratory Analyses[g]					
Antimony	32	3.2	6010	±20	±20
Arsenic	0.4	0.1[f]	7060	±20	±20
Barium	5600	0.2	6010	±20	±20
Cadmium	80	0.4	6010	±20	±20
	400	0.7	6010	±20	±20
Chromium	400	0.7	6010	±20	±20
Copper	3000	0.6	6010	±20	±20
Cobalt	TBC[c]	0.7	6010	±20	±20
Lead	500	4.2	6010	±20	±20
Lithium	TBC[c]	0.5	6010	±20	±20
Mercury	24	0.2	7471	±20	±20
Nickel	1600	0.015	6010	±20	±20

c

Contaminant	Present Screening Action Level[a]	Practical Quantitation Limit mg/kg	Analytical Method[b]	Accuracy (%)	Relative Percent Difference[b] (%)
Selenium	400	7.5	6010	±20	±20
Silver	400	0.7	6010	±20	±20
Thallium	6.4	4.0	6010	±20	±20
Uranium	240	0.03	(e)	±20	±20
Vanadium	560	0.8	6010	±20	±20
Zinc	24,000	0.2	6010	±20	±20
Inorganic Parameters - XRF Analyses[g]					
Antimony	32	29.4	(h)	±50	±35
Arsenic	0.4	42	(h)	±50	±35
Barium	5600	5.1	(h)	±50	±35
Cadmium	80	84	(h)	±50	±35
Chromium	400	93	(h)	±50	±35
Copper	3000	48	(h)	±50	±35
Cobalt	TBD[c]	120	(h)	±50	±35
Lead	500	18.9	(h)	±50	±35
Mercury	24	24	(h)	±50	±35
Nickel	1.600	72	(h)	±50	±35
Selenium	400	20.7	(h)	±50	±35
Silver	400	36	(h)	±50	±35
Thallium	6.4	9.3	(h)	±50	±35
Uranium[i]	240	13	(h)	±50	±35
Zinc	24,000	39	(h)	±50	±35

a Source: LANL 1993, 1017, Appendix J. Action level criteria in effect at the time of sampling will be used in analyzing the data from Phase I activities. Units are mg/kg.
b Source: (LANL 1991, 0553), Appendix O. Methods are from EPA SW-846 (EPA 1987, 0518) for the laboratory analyses. The instrumental detection limits for soil samples are calculated based on the minimum sample weight required, final volume of the solution, and the instrumental detection limits for aqueous samples. The XRF analyses will be conducted as field methods following the SOP indicated in Table II-3.
c To be determined. Action level criteria were not available at the time of Work Plan preparation.
d To be determined. IDLs vary for different sample matrices and will be determined for the OU 1154 matrices as part of the Phase I sampling effort under this Work Plan.
e Delayed Neution Activation Analysis method to be used.
f Analyses for arsenic will be conducted by U.S. EPA SW-846 Method 6010. If arsenic concentration in the sample is below the detection limit of SW-846 Method 6010 (5.3 mg/kg), then analysis will be conducted by SW-846 Method 7060.
g Instrument detection limits are given in place of practical Quantitation Limits for inorganic parameters.
h U.S. EPA Environmental Response team standard operating procedures for Spectrace 9000 field portable x-ray fluorescence spectrometer, December, 1992.
i No uranium standard is presently available for XRF analysis.

TABLE II-3

Standard Operating Procedures for Operable Unit 1154

Standard Operating Procedure Number	Description
General Instructions	
LANL-ER-SOP-01.01	General Instructions for Field Investigations
LANL-ER-SOP-01.02	Sample Containers and Preservation
LANL-ER-SOP-01.03	Handling, Packaging, and Shipping of Samples
LANL-ER-SOP-01.04	Sample Control and Field Documentation
LANL-ER-SOP-01.05	Field Quality Control Samples
LANL-ER-SOP-01.06	Management of RFI-Generated Wastes
TBD[b]	Data Validation Procedures
LANL-ER-SOP-01.07	Personnel Decontamination
LANL-ER-SOP-01.08	Field Decontamination of Drilling and Sampling Eqiupment
LANL-ER-SOP-01.09	Sample Labeling
Health and Safety in the Field[c]	
LANL-ER-SOP-02.01[a]	Personal Protective Equipment
LANL-ER-SOP-02.02[a]	Respirators
LANL-ER-SOP-02.03[a]	Pre-Entry Briefings for Site Personnel
LANL-ER-SOP-02.04[a]	Pre-Entry Briefings for Visitors
LANL-ER-SOP-02.05[a]	Safety Meetings and Inspections
LANL-ER-SOP-02.06[a]	Heat and Cold Stress and Natural Hazards
LANL-ER-SOP-02.09[a]	Accident/Incident Reporting
LANL-ER-SOP-02.11[a]	Training and Medical Surveillance
Field Surveys	
TBD[b]	Hand-held Instruments for Field Screening of VOCs
TBD[b]	Hand-held Instruments for Field Screening of Radioactive Substances
TBD[b]	X-ray Fluorescence Analysis of Environmental Soil and Sludge Samples
Drilling, Excavating, and Soil Sampling Techniques	
LANL-ER-SOP-04.01	Drilling Methods and Drill Site Management
LANL-ER-SOP-04.04[a]	General Borehole Logging
LANL-ER-SOP-04.05	Monitor and Control of Dust during Drilling
TBD[b]	Spill Control During Drilling
Sampling Techniques	
LANL-ER-SOP-06.03	Sampling for Volatile Organics
LANL-ER-SOP-06.09	Spade and Scoop Method for Collection of Soil Samples
LANL-ER-SOP-06.10	Hand Auger and Thin-Wall Tube Sampler
LANL-ER-SOP-06.11	Stainless Steel Surface Soil Sampler

Table II-3 (cont.)

LANL-ER-SOP-06.14	Sediment Material Collection
LANL-ER-SOP-06.24	Sample Collection from Split Spoon Sampleus and Shelby Tube Samples
LANL-ER-SOP-06.26	Core Barrel Subsurface Sampling
Curatorial Sample Management	
LANL-ER-SOP-12.01	Field Logging, Handling, and Documenting Borehole Samples
Quality Procedures	
LANL-ER-QP-01.1Q	Audits
LANL-ER-QP-01.2Q	Surveys
LANL-ER-QP-01.3Q	Deficiency Reporting
Administrative Procedures	
LANL-ER-AP-01.3	Review and Approval of Environmental Restoration Program Plans and Reports
LANL-ER-AP-01.5	Revision or Interim Change of Environmental Program Controlled Documents
ICN-NO-002	Interim Change Notice for LANL-ER-AP-01.5, R0
LANL-ER-AP-02.1[a]	Procedure for LANL ER Records Management
LANL-ER-AP-03.2	Handling Media and Public Requests for Information During Field Work
LANL-ER-AP-04.1	Identification, Documentation, and Reporting of Newly Discovered Potential Release Sites for the Environmental Restoration Program
LANL-ER-AP-04.2	Reporting of Newly Identified Releases from Solid Waste Management Units

a This procedure is in draft form.
b This procedure is in preparation.
c The H & SOPs have been delted from the ER SOP manual and transferred to the ER H & S Manual.

3.4 Quality Assurance Objectives for Accuracy

The QA objectives for accuracy for the OU 1154 RFI analyses are listed in Table II-2. These limits are derived from SW-846 (EPA 1987, 0518) methods or from the methods listed in Table II-2.

3.5 Representativeness, Completeness, and Comparability

The representativeness of the analytical data will be attained through the technical approach described in Chapter 4 of this work plan and the specific sampling plans described in Chapter 5. Additional information to be used to attain representativeness is included in the discussions of site-specific data needs and DQOs in Chapter 5 and in the list of SOPs given in Table II-3.

The completeness goal of 90% set for the ER Program will apply to the XRF analyses conducted during the OU 1154 RFI. However, a completeness goal of 100% will apply for samples collected for laboratory analyses, since fewer than 5 samples will be collected for laboratory analysis at each site. Additional actions, such as additional XRF analyses, or collection of additional samples for laboratory analysis, will be required when the completeness goals are not achieved.

Comparability will be achieved through the use of the standard methods listed in Table II-2 as well as through the use of the LANL-ER-SOPs listed in Table II-3. The comparability requirements specified in Chapter 5 of the Generic QAPjP will apply to the OU 1154 RFI.

3.6 Field Measurements

The primary DQOs for field measurements described in Section 5.6 of the Generic QAPjP apply to the OU 1154 RFI. These DQOs will be achieved through the use of appropriate methodologies described in the LANL-ER-SOPs for each site activity. These SOPs are listed in Table II-3.

3.7 Data Quality Objectives

The qualitative and quantitative statements that specify the quality of the data required to support the OU 1154 RFI decision process are described in the work plan. The analyte-specific precision and accuracy requirements presented in Table II-2 of this QAPjP describe the QA objectives for the measurement data that were selected to provide for the collection of analytical data with acceptable levels of uncertainty. The decision process and acceptable levels of uncertainty are presented in Chapters 4 and 5 of the work plan. Site-specific decisions and investigation objectives are described in Chapter 5. The sampling and analysis strategies and approaches as well as the required sampling and analyses for each site are also described in Chapter 5.

3.8 Quality Improvement

The OU 1154 Phase I sampling will be conducted following the quality improvement guidelines described in Chapter 20 of the QPP. The quality improvement activities to be conducted as part of the project include the following:

- A project kickoff meeting where all project participants will meet to discuss the responsibilities of each participant, the project schedules and how they impact the overall project, nonconformance reporting, health and safety requirements, and to get feedback on the project plans.

- Readiness reviews prior to commencing each major field activity to cover the same topics discussed at the project kickoff meeting and how these topics relate to the field activity to be conducted.

- Daily tailgate meetings to review the daily sampling objectives and health and safety aspects of the work to be conducted by the field crew that day.

- A close-out meeting at end of each major sampling activity to review the performance and to suggest improvements for subsequent activities.

4.0 SAMPLING PROCEDURES

The activities to be conducted during the OU 1154 RFI will follow the procedures described in this section and in Chapter 6 of the Generic QAPjP. The SOPs to be used during the OU 1154 RFI are listed in Table II-3. These procedures cover the sample collection, handling, and shipping procedures, as well as the QA procedures that will be followed during the project. These procedures were selected from the ER Program procedures listed in Appendix M of the IWP (LANL 1993, 1017).

4.1 Quality Control Samples

Quality Control samples will be collected as described in Section 6.1 of the Generic QAPjP with the exceptions given in Section 3.1 of this QAPjP.

4.2 Sample Preservation During Shipment

Samples will be handled following the guidance in Chapter 6 of the Generic QAPjP and the appropriate LANL-ER-SOPs listed in Table II-3. The following specific SOPs will be used for sample preservation during shipment. Samples will be controlled and documented in the field following LANL-ER-SOP-01.04, Sample Control and Field Documentation. Samples will be contained and preserved following LANL-ER-SOP-01.02, Samples Containers and Preservation. The essential sample container and preservation information from LANL-ER-SOP-01.02 pertaining to the OU 1154 RFI is summarized in Table II-4. The handling, packaging, and shipping of samples will follow LANL-ER-SOP-01.03, Handling, Packaging, and Shipping of Samples.

4.3 Equipment Decontamination

Equipment will be decontaminated following the procedure described in Section 6.3 of the Generic QAPjP and the appropriate LANL-ER-SOP, General Equipment Decontamination. In addition, any equipment-specific decontamination procedures specified in the sampling equipment SOPs will also be followed.

4.4 Sample Designation

Sample designation will be implemented as described in Section 6.4 of the Generic QAPjP and LANL-ER-SOP-01.04, Sample Control and Field Documentation. The sample numbers will be designated with the assistance of ER Program personnel familiar with LANL-ER-SOP-01.04 and with assistance from the SCF TTL.

TABLE II-4

Sample Container Types, Volumes, Preparation, Special Handling, Preservation, Holding Times, and Minimum Sample Quantities

Analysis	Containers	Handling and Preservation	Holding Time
Soil Samples			
Volatiles including *iso*-propyl alcohol	Three 60 ml amber glass with Teflon-lined cap	Store 4 degrees C, handle upwind from equipment fumes, no contact with plastic or gloves	14 days
Metals for laboratory and X-ray Fluorescence Analyses	1,250 ml plastic	Store 4 degrees C	6 months all metals except mercury, which is 28 days
Total Petroleum Hydrocarbons	1,250 ml plastic	Store 4 degrees C	7 days until extraction, 30 days thereafter
Waste Samples			
Metals	1500 ml plastic	Preserved with HNO_3 to ph<2 and store at 4°C	6 months, except mercury, which is 28 days
TCLP Analysis	4,500 ml amber glass with Teflon-lined cap	None	TCLP extraction; 28 days for mercury; 180 days for all other metals
Corrosivity	One 60 ml glass with Teflon-lined cap	None	14 days

5.0 SAMPLE CUSTODY

5.1 Overview

The strict chain-of-custody procedures contained in LANL-ER-SOP-01.04, Sample Control and Field Documentation, and described in Section [illegible].1 of the Generic QAPjP will be followed during the OU 1154 RFI. These procedures will be followed to help ensure the proper handling of samples from collection to analysis, including the final disposition of the analytical samples.

5.2 Field Documentation

Field documentation activities to be conducted during the OU 1154 RFI will follow the procedures described in this section and in Chapter 7 of the Generic QAPjP. The SOPs to be used during the OU 1154 RFI are listed in Table II-3. These SOPs cover the sample control and field documentation, the sample collection, and the QA procedures that will be followed during the project.

5.2.1 Sample Identification

The samples will be identified following LANL-ER-SOP-01.04, Sample Control and Field Documentation, as described in Section 7.2.1 of the Generic QAPjP.

5.2.2 Field Logs

Field logs will be kept following the procedure described in Section 7.2.2 of the Generic QAPjP and in Chapter 4 of the OU 1154 RFI work plan.

5.2.3 Data Collection Forms

Data collection forms will be used following the appropriate LANL-ER-SOPs as described in Section 7.2.3 of the Generic QAPjP.

5.2.4 Corrections to Documentation

Incorrect entries will be crossed out with a single line and signed and dated by the person originating the entry and the appropriate LANL ER Program technical field team leader as described in Section 7.2.4 of the Generic QAPjP. The correct information will be entered and the correction signed and dated by the person making the correction. There will be no erasures or deletions from any type of data document record.

5.3 Sample Coordination Facility

All samples will initially be transported by the FTL or designated field team member to the LANL SCF. As described in Section 7.3 of the Generic QAPjP, the LANL SCF will coordinate the chemical analyses required for the OU 1154 field samples. The procedures for sample handling will follow those described in Section 4 of this QAPjP.

5.4 Laboratory Documentation

The laboratory documentation procedures described in Section 7.4 and the related subsections in the Generic QAPjP will be followed for all samples collected and analyzed during the OU 1154 RFI.

5.5 Sample Handling, Packaging, and Shipping

The procedures described in Section 7.5 of the Generic QAPjP will be followed for all samples collected and analyzed during the OU 1154 RFI. As described in Section 5.3 above, all samples will initially be transported to the LANL SCF, which will be responsible for sample handling, packaging, and shipping following the appropriate Laboratory procedures described in Section 4 of this QAPjP.

5.6 Final Evidence File Documentation

Project participants will maintain records to document the QA/QC activities and to provide support for possible evidential proceedings. Records generated during the OU 1154 RFI are the property of the Laboraatory's ER Program Office. The OU 1154 Records Management Plan (Annex IV to the OU 1154 RFI Work Plan) and the LANL Records Management Program in Annex IV of the IWP (LANL 1993, 1017) describe the procedures that will be followed to provide final evidence documentation.

6.0 CALIBRATION PROCEDURES AND FREQUENCIES

The calibration procedures and their frequencies for the OU 1154 RFI are described in Chapter 8 of the Generic QAPjP.

7.0 ANALYTICAL PROCEDURES

The analytical procedures for the OU 1154 RFI are listed in Table II-2. These procedures will be used for field testing and screening and laboratory analysis as described in Chapter 9 of the Generic QAPjP.

For the XRF method specified in Table II-2, the selected field analytical team will provide analytical method SOPs for the analyses to be conducted. The XRF analysis method will be documented to demonstrate that the appropriate level of data quality can be achieved before the methods are approved for use in the OU 1154 RFI. The XRF analyses will be performed by an analytical chemist with demonstrated proficiency for each parameter required.

8.0 DATA REDUCTION, VALIDATION, AND REPORTING

Data reduction, validation, and reporting will be conducted by LANL ER Program personnel and subcontractors as described in Section 10 of the Generic QAPjP. In addition, the laboratory analytical data will be validated by individuals independent from the analytical laboratory that produced the data. The validation process is intended to determine whether the data received are of acceptable quality based on the DQOs specified in this QAPjP and the OU 1154 RFI Work Plan. The data validation procedures will be conducted under the supervision of the Environmental Chemistry TTL following procedures approved by the Environmental Chemistry TTL.

9.0 INTERNAL QUALITY CONTROL CHECKS

Internal QC checks will be conducted as described in Chapter 11 of the Generic QAPjP, with the exceptions described in Section 3.1 of this QAPjP. Internal checks of the XRF spectrometer operation will be conducted as described in the appropriate standard operating procedure.

10.0 PERFORMANCE AND SYSTEM AUDITS

Announced and unannounced performance and system audits will be conducted during the OU 1154 RFI as identified in Chapter 12 of the Generic QAPjP. Audits will be conducted at least once per year for field and laboratory procedures used during the OU 1154 RFI. These audits will follow the ER Program procedures for audits and surveys given in Table II-3. Audits will also be conducted in response to recommendations from the OUPL and ER Program management (including the QPPL).

11.0 PREVENTIVE MAINTENANCE

The preventive maintenance procedures for both field and laboratory equipment specified in Chapter 13 of the Generic QAPjP will be followed during the OU 1154 RFI.

12.0 SPECIFIC ROUTINE PROCEDURES USED TO ASSESS DATA PRECISION, ACCURACY, REPRESENTATIVENESS, AND COMPLETENESS

In order to provide data that are comparable to the data produced for other OU RFIs, the OU 1154 RFI will use the procedures described in Chapter 14 of the Generic QAPjP to assess data precision, accuracy, representativeness, and completeness.

13.0 CORRECTIVE ACTION

The procedures, reporting requirements, and authority for initiating corrective action during the OU 1154 RFI will follow those defined in Chapter 15 of the Generic QAPjP and in the LANL-ER-QP-01.3Q, Deficiency Reporting or as defined in revised procedures.

14.0 QUALITY ASSURANCE REPORTS TO MANAGEMENT

Quality Assurance reports to management will be prepared following the guidelines provided in Chapter 16 of the Generic QAPjP.

REFERENCES

EPA (US Environmental Protection Agency), December 29, 1980. "Interim Guidelines and Specifications for Preparing Quality Assurance Project Plans," QAMS-005/80, Office of Monitoring Systems and Quality Assurance, Office of Research and Development, Washington, DC. (EPA 1980, 0552)

EPA (US Environmental Protection Agency), December 1987. "Test Methods for Evaluating Solid Waste Physical/Chemical Methods," SW-846, proposed update package for third edition, Office of Solid Waste and Emergency Response, Washington, DC. (EPA 1987, 0518)

LANL (Los Alamos National Laboratory), May 1991. "Generic Quality Assurance Project Plan," Rev. 0, Environmental Restoration Program, Los Alamos, New Mexico. (LANL 1991, 0412)

LANL (Los Alamos National Laboratory), November 1992. "Installation Work Plan for Environmental Restoration," Revision 2, Los Alamos National Laboratory Report LA-UR-93-3887, Los Alamos, New Mexico. (LANL 1993, 1017)

Annex III

Health and Safety Plan

Executive Summary

Chapter 1
Introduction

Chapter 2
Background Information for Operable Unit 1154

Chapter 3
Environmental Setting

Chapter 4
Technical Approach

Chapter 5
Potential Release Sites

Chapter 6
Recommendations for No Further Action

Annexes

Appendices

1.0 INTRODUCTION

This Operable Unit Health and Safety Plan (OUHSP) for Operable Unit (OU) 1154 is specific to the tasks described in this Work Plan for Phase I activities.

1.1 Purpose

The purpose of this OUHSP is to recognize potential health and safety hazards, describe techniques for their evaluation, and identify control methods. The goal is to eliminate injuries and illness; to minimize exposure to physical, chemical, biological, and radiological agents during environmental restoration (ER) activities; and to provide contingencies for events that may occur while these efforts are under way.

It is intended that project managers, health and safety professionals, laboratory managers, and regulators use this OUHSP as a reference for information about the OU 1154 health and safety program and procedures. OU specific information can be found in Sections 3 and 4 of this document. The other sections of this document contain general information applicable to all OUs. Detailed Site-Specific Health and Safety Plans (SSHSPs) and procedures will be prepared subsequent to this document.

The Health and Safety Division Hazardous Waste Operations (HAZWOP) Program establishes laboratory policies for health and safety activities at ER sites. The hierarchy of health and safety documents for the Los Alamos National Laboratory (the Laboratory) ER Program is as follows:

1. Installation Work Plan, Health and Safety Program Plan (IWPHSPP)
2. OUHSP
3. SSHSP

The first document is more general, while the others become increasingly more specific and detailed. While each document is written so it can stand alone, the contents and references to these and other documents are considered when making decisions.

1.2 Applicability

The requirements specified in this plan apply to all personnel at ER sites, including Laboratory employees, supplemental work force personnel, regulators, and visitors. There are no exceptions.

1.3 Regulatory Requirements

Government-owned, contractor-operated facilities must comply with Occupational Safety and Health Administration (OSHA), U.S. Department of Energy (DOE) Orders, U.S. Environmental Protection Agency (EPA) regulations, and specific requirements from the States. The SSHSP will include the applicable regulatory requirements.

1.4 Required Elements of the SSHSP

The Code of Federal Regulations Title 29 Part 1910 Section 120, paragraph (b) (4) (ii) requires that the site health and safety plan, as a minimum, address the following elements:

1. A safety and health risk or hazard analysis for each site task and operation found in the work plan.
2. Employee training appropriate for the tasks to be performed.
3. Personal protective equipment to be used by employees for each task and operation being conducted.
4. Medical surveillance requirements for site workers.
5. Frequency and types of air monitoring, personnel monitoring and environmental sampling techniques and instrumentation to be used, including the methods of maintenance and calibration of monitoring and sampling equipment.
6. Site control measures.
7. Decontamination procedures.
8. The emergency response plan for safe and effective responses to emergencies.
9. Co[illegible]ned space entry procedures, when applicable.
10. A [illegible] containment program.

Each SSHSP prepared for work at sites within OU 1154 will address the above elements, as a minimum, through the use of the ER Program model SSHSP format.

When special conditions exist, the Site Safety Officer (SSO) may submit to the Health and Safety Project Leader (HSPL) a written request for variance from a specific health and safety requirement. If the HSPL agrees with the request, it will be reviewed by the Operable Unit Project Leader (OUPL) or a designee. Higher levels of management may be consulted as appropriate. The condition of the request will be evaluated, and if appropriate, the HSPL will grant a written variance specifying the conditions under which the requirements may be modified. The variance will become part of the SSHSP.

1.5 Review and Approval

This document will be effective after it has been reviewed and approved by the appropriate Laboratory organizations. Signatures of approval are required.

This document will be revised as necessary and at least annually. Revisions will reflect changes in the scope of work, site conditions, work procedures, site data, contaminant monitoring, or visual information technology, policies, and/or procedures. Changes must be approved by the HSPL and OUPL. A complete review will be conducted should feasibility studies or remediation be necessary.

2.0 ORGANIZATION, RESPONSIBILITY, AND AUTHORITY

Figure I-1 in Annex I illustrates the organization chart for OU 1154. This section provides a description of the health and safety responsibilities and lines of communication within that organization structure.

2.1 General Responsibilities

The Laboratory's Environment, Safety, and Health (ES&H) Manual describes managers' and employees' responsibilities for conducting safe operations and providing for the safety of contract personnel and visitors. The general safety responsibilities for ER activities are summarized in the IWPHSPP. Line Management is responsible for implementing health and safety requirements.

Any individual who observes an operation that presents a clear and imminent danger to the environment or to the safety and health of employees, subcontractors, visitors, or the public has the authority to initiate a **stop-work action** as described in Laboratory Procedure (LP) 116-01.0. Any individual who observes a clear and imminent danger shall follow reporting requirements as specified in LP 116-01.0. Upon initiation of stop-work actions, related activities are documented on the Stop-Work Report Form and the log for Stop-Work Reports. ER personnel initiating stop-work actions shall notify the ER Program HSPL and the OUPL.

2.1.1 Kick-Off Meeting

A health and safety kick-off meeting will be held before field work begins. The purpose of the meeting is to review the responsibilities, authority, lines of communication, and scheduling for the field work. The HSPL will be notified of the meeting and has the authority to delay field work until the kick-off meeting is held.

2.1.2 Readiness Review

A field readiness review must be completed by the OUPL at least 20 working days in advance of field activities. The HSPL is responsible for approving the health and safety section of the readiness review.

2.2 Individual Responsibilities

Laboratory employees and supplemental work force personnel are responsible for health and safety during ER Program activities. Figure I-1 in Annex I illustrates the OU 1154 RFI organizational chart, showing the line organization. The personnel with direct authority for implementation of SSHSPs are the HSPL, the OUPL and the SSO (works as a field team member). The responsibilities of each person are as described in the following subsections.

2.2.1 Health and Safety Project Leader

The HSPL is responsible for preparing and updating the IWPHSPP. The HSPL helps the OUPL in identifying resources to be used for the preparation and implementation of the OUHSP. Final approval of the IWPHSPP, OUHSP, and SSHSP is the responsibility of the

HSPL. In conjunction with the field team leaders, the HSPL oversees daily health and safety activities in the field, including scheduling, tracking deliverables, and resource utilization.

2.2.2 Operable Unit Project Leader

The OUPL is responsible for all investigation activities for his/her assigned OU. Specific health and safety responsibilities include:

- preparing, reviewing, implementing, and revising OUHSPs and SSHASPs;
- interfacing with the HSPL to resolve health and safety concerns; and
- notifying the HSPL of schedule and project changes.

2.2.3 Site Safety Officer

An SSO other than the field team leader will be assigned. The qualifications of the SSO depend on the potential hazards for the specific tasks to be conducted. The SSO will interface with the safety personnel at TA-57. Contractors must assign their own SSO.

The SSO is responsible for ensuring that trained and competent personnel are on-site. This includes industrial hygiene and health physics technicians and first aid/cardiopulmonary resuscitation responders. The SSO may fill any or all of these roles.

The SSO has the following responsibilities:

- advising the HSPL and OUPL of health and safety issues;
- performing and documenting initial inspections for all site equipment;
- notifying proper Laboratory authorities of injuries or illnesses, emergencies, or stop-work orders;
- evaluating the analytical results for health and safety concerns;
- determining protective clothing (PC) requirements;
- inspecting PC and equipment;
- determining personal dosimetry requirements for workers;
- maintaining a current list of telephone numbers for emergency situations;
- providing an operating radio transmitter/receiver if necessary;
- maintaining an up-to-date copy of the SSHSP for work at the site;

- controlling entry and exit at access control points;
- establishing and enforcing the safety requirements to be followed by visitors;
- briefing visitors on health and safety issues;
- maintaining a logbook of workers entering the site;
- determining whether workers can perform their jobs safely under prevailing weather conditions;
- monitoring work parties and conditions;
- controlling emergency situations in collaboration with Laboratory personnel;
- ensuring that all personnel are trained in the appropriate safety procedures and are familiar with the SSHSP and that all requirements are followed during OU activities;
- conducting daily health and safety briefings for field team members;
- stopping work when unsafe conditions develop or an imminent hazard is perceived;
- inspecting to determine whether SSHSP is being followed; and
- maintaining first aid supplies.

2.3 Visitors

Site access will be controlled so that only verified team members will be allowed in work areas or areas containing potentially hazardous materials or conditions. Special passes or badges may be issued. Any visitors who are on-site to collect or split samples or to perform audits and suveillances must meet all the health and safety requirements of any field sampling team for that site and will be considered verified team members. Visitors present for purposes other than sample collection or audits will not be permitted to enter the contaminated areas of the site.

2.4 Supplemental Work Force

All supplemental work force personnel performing site investigations will be responsible for developing or adopting LANL-approved health and safety plans that cover their specific project assignments. As a minimum, the plans shall conform to the requirements of the SSHSP governing all site activities. The HSPL has the ultimate authority to accept or reject SSHSPs prepared by supplemental work force personnel for specific project assignments.

Contractors will adhere to the requirements of all applicable health and safety plans. Laboratory personnel will monitor activities for compliance with the requirements. Failure to adhere to these requirements will cause work to stop until compliance is achieved.

Contractors will provide their own health and safety functions unless other contractual agreements have been arranged. Such functions may include, but are not limited to, providing qualified health and safety officers for site work, imparting a corporate health and safety environment to their employees, providing calibrated industrial hygiene and radiological monitoring equipment, enrolling in an approved medical surveillance program, supplying approved respiratory and personal protective equipment (PPE), providing safe work practices, and training hazardous waste workers.

2.5 Personnel Qualifications

The HSPL will establish minimum training and competency requirements for on-site personnel. These requirements will meet or exceed the required DOE Orders and 29 CFR 1910.120 regulations.

2.6 Health and Safety Oversight

Oversight will be maintained to ensure compliance with regulatory requirements. The Health and Safety Division is responsible for developing and implementing the oversight program. The frequency of field verifications will depend on the characteristics of the site, the equipment used, and the scope of work.

3.0 SCOPE OF WORK

The scope of work covered by this OUHSP are the Phase I activities described in the OU 1154 RFI Work Plan.

3.1 Comprehensive Work Plan

The IWPHSPP for ER targets OU 1154 for investigation. The initial phase is investigation and characterization, involving environmental sampling and field assessment of the areas. This OUHSP addresses the tasks in the Phase I study described in this work plan. Tasks for additional phases will be addressed in revisions to this document.

3.2 Operable Unit Description

OU 1154 consists of 16 potential release sites (PRSs). These include SWMUs and AOCs. Thorough descriptions and histories of these sites can be found in Section 5 of the work plan. Table III-1 is a list of the PRS aggregates that summarize the PRSs, the potential hazards, and the work planned at this time.

4.0 HAZARD IDENTIFICATION AND ASSESSMENT

The SSO or designee will monitor field conditions and personnel exposure to physical, chemical, biological, and radiological hazards. If a previously unidentified hazard is identified, the SSO will contact the field team leader and the HSPL to assess the hazard and modify the SSHASP as needed. A hazard assessment will be performed to identify the potential harm, the likelihood of occurrence, and the measures to reduce risk.

4.1 Physical Hazards

Injuries caused by physical hazards are preventable. Some physical hazards such as open trenches, loud noise, and heavy lifting are easily recognized. Others, such as heat stress and sunburn, high altitude, rock slides, very irregular terrain, lightning, and other hazards prevalent at OU 1154, are less apparent. Physical hazards will be addressed thoroughly in the SSHP.

4.2 Chemical Hazards

A variety of chemical contaminants are known or are suspected to be present at this OU. The most important of these is hydrogen sulfide (H_2S). H_2S is known to be prevalent at the site with the potential for high concentrations. Each SSHSP must address the potential for H_2S emissions during all field operations, especially intrusive operations in

Table III-1—OU1154 PRSs

Paste	Description	Tasks	Chemicals of Concern
Group 1: Drilling Pits			
57-001(a)	GT-1 drilling pit (r)	Geodetic Survey and Soil Sampling	Hydrogen Sulfide, Metals, Isopropyl Alcohol
	GT-2 drilling pit (n)	"	"
	EE-1 drilling pit (n)	"	"
	EE-2 drilling pit (n)	"	"
	EE-2A workover pit (n)	"	"
	EE-3 drilling pit	"	"
	EE-3A workover pit (n)	"	"
Group 2: Settling and Reserve Ponds			
57-001(b)	GT-2 settling pond (GTP-3) (a)	Geodetic Survey and Soil Sampling	Hydrogen Sulfide, Metals
	Middle settling pond (GTP-2) (r)	"	"
	EE-1 settling pond (GTP-1) (a)	"	"
	Pond Infiltration system (a)	"	"
	5-million gallon pond (a)	"	"
Group 3: Sludge Disposal Pit			
57-002	Sludge pit	Geodetic Survey and Soil Sampling	Hydrogen Sulfide, Metals
Group 4: Chemical Waste Storage Tank			
	Chemical waste storage tank	Geodetic Survey and Soil Sampling	Metals and Volatile Organic Compounds
	Chemistry Trailer drainfield (n)	"	"
Group 5: Bulk Storage Areas			
57-003	Container Storage Area	Geodetic Survey and Soil Sampling	Petroleum Hydrocarbons and Metals

(a) = active in 1993; (n) = no information, it has been restored or may not have existed; (r) = restored during operations.

the sludge pit and at the former settling ponds. Site entry, monitoring, and emergency egress procedures will be specified for each intrusive activity.

The SSHSP will provide information for known or suspected contaminants, which will include: American Conference of Governmental Industrial Hygienists (ACGIH) threshold limit value (TLV), immediately dangerous to life and health concentrations, exposure symptoms, ionization potential and relative response factor for commonly used instruments (re-evaluated when the particular instrument is selected), the best instrument for screening, and the anticipated detection limits.

4.3 Radiological Hazards

Radionuclides are not known or suspected to be present. The SSHSP will provide information for any known or suspected radionuclides that will include the type of radiation emitted, the permissible exposure concentrations, and the monitoring instruments recommended for detection under field conditions.

4.4 Biological Hazards

There are several biological hazards found at Los Alamos that are not common in other parts of the country. These include, but are not limited to: hantavirus, rattlesnakes, skunks, coyote, elk, ticks, plague, giardia lamblia, and black widow spiders.

4.5 Task-by-Task Risk Analysis

A task-by-task risk analysis is required by 29 CFR 1910.120 and will be included with each SSHSP. This process analyzes the operations and activities for specific hazards by task. Examples of some of the tasks that should be analyzed and documented in the SSHSP are:

- work in remote areas,
- drilling,
- hand augering,
- trenching,
- septic system sampling,
- sampling on ponds and sludge pits,
- geodetic surveying,
- soil sampling,
- radiological monitoring, and
- canyon side sampling.

Other tasks should be considered for inclusion by the SSO. The task analysis will include a general characterization of the health and safety concerns at an individual PRS or groups of PRSs and an evaluation of risks posed when performing individual tasks such as drilling, hand augering, etc. When chemical hazards are known, they will be identified in the SSHSP and categorized in regard to the relative degree of hazard posed to site workers. Physical hazards at each PRS or PRS group included in the SSHSP will be identified and evaluated so that workers may take precaution against the often overlooked physical hazards at a site.

5.0 SITE CONTROL

The site is on U.S. Forest Service land and is open to public access with the exception of the active site at TA-57 (Figure 3-1 in the work plan). TA-57 is fenced and guarded during working hours.

5.1 Initial Site Reconnaissance

Initial site reconnaissance may involve surveyors, archaeologists, biological resource personnel, etc. Health and safety concerns that may be present for these nonintrusive activities must be addressed to protect personnel. The OUPL and HSPL will identify these concerns and institute measures to protect environmental impact assessment personnel.

5.2 Site-Specific Health and Safety Plans

Each field activity conducted during the OU 1154 RFI will be included in a SSHSP. Planning, special training, supervision, protective measures, and oversight needs are different for each activity, and the SSHSP must address this variability.

This OUHSP provides detailed information about the OU 1154 health and safety program and procedures. The SSHSP addresses the safety and health hazards of specific site activities and includes requirements and procedures for employee protection. All OU 1154 SSHSPs derive from this OUHSP.

The ER Program model outline for an SSHSP follows OSHA requirements and serves as a guide for best management practice. Those performing the field work are responsible for completing the plan.

Changes to the SSHSP must be made in writing following the change order control process described in each SSHSP. The HSPL shall approve changes, and site personnel shall be updated through daily tailgate meetings. Records of SSHSP approvals and changes will be maintained by the SSO.

5.3 Work Zones

Maps identifying work zones will be included with each SSHSP. Markings used to designate each zone boundary (red or yellow tape, fences, barricades, etc.) will be discussed in the plan. Evacuation routes should be upwind or crosswind of the exclusion zone. A muster area must be designated for each evacuation route. Discrete zones are not required for every field event. The SSO will determine work zones.

5.4 Secured Areas

Secured areas shall be identified and shown on the appropriate site maps in the SSHSPs. Procedures and responsibilities for maintaining secured areas must be described. Standard Laboratory security procedures will be followed for accessing secure areas. All contractors and visitors must be processed through the badge office before entering secure areas. It is the responsibility of the OUPL to see that contractor personnel have badges. It is the responsibility of all Laboratory employees to enforce security measures.

5.5 Communications Systems

Portable telephones, CB radios, and two-way radios may be used for on-site communications. Portable phones may not be usable in some of the remote areas of OU 1154. Each type of communication equipment used will be checked for proper functioning in the field prior to the start of work each day.

5.6 General Safe Work Practices

Workers will be instructed on safe work practices to be followed when performing tasks and operating equipment needed to complete the project. Daily safety tailgate meetings will be conducted at the beginning of the shift to brief workers on proposed activities and special precautions to be taken. General safe work practices will be included in the SSHSP. Topics will include use of the buddy system; eating, drinking, smoking at the site; housekeeping at the site; contingency planning, worker conduct while on-site and other practices that may be appropriate at the site.

5.7 Specific Safe-Work Practices

The following subsections describe specific work practices that will be followed at OU 1154.

5.7.1 Electrical Safety-Related Work Practices

The most effective way to avoid accidental contact with electricity is to de-energize the system or maintain a safe distance from the energized parts/line. OSHA regulations require minimum distances from energized parts. An individual working near power lines must maintain at least a 10 ft clearance from overhead lines of 50 kilovolts (kV) or less. The clearance includes any conductive material the individual may be using. For voltages over 50 kV, the 10 ft clearance must be increased 4 in. for every 10 kV over 50 kV. For underground electrical service the underground locator service should be contacted before digging.

5.7.2 Grounding

Grounding is a secondary form of protection that ensures a path of low resistance to ground if there is an electrical equipment failure. A properly installed ground wire becomes the path for electrical current if the equipment malfunctions. Without proper grounding, an individual could become the path to ground if he/she touches the equipment. An assured electrical grounding program and/or ground fault circuit interrupters are required.

5.7.3 Lockout/Tagout

All site workers follow a standard operating procedure for control of hazardous energy sources [Laboratory Administrative Requirement (AR) 8-6, LP 106-01.1). Lockout/tagout procedures are used to control hazardous energy sources, such as electricity, potential energy, thermal energy, chemical corrosivity, chemical toxicity, or hydraulic and pneumatic pressure.

5.7.4 Confined Space

In the unlikely event that work is to be conducted in confined spaces, entry and work to be conducted in confined spaces shall adhere to procedures proposed in the Laboratory Confined Space Entry Program. These procedures require that a Confined Space Entry Permit be obtained and posted at the work site. Prior to entry, the atmosphere shall be tested for oxygen content, flammable vapors, carbon monoxide, and other hazardous gases. Continuous monitoring for these constituents shall be performed if conditions or activities have the potential to adversely affect the atmosphere.

5.7.5 Handling Drums and Containers

Drums and containers used during all RFI activities shall meet U.S. Department of Transportation, OSHA, and EPA regulations. Work practices, labeling requirements, spill containment measures, and precautions for opening drums and containers shall be in accordance with 29 CFR 1910.120. Drums and containers that contain radioactive material must also be labeled in accordance with AR 3-5, Shipment of Radioactive Materials; AR 3-7, Radiation Exposure Control; and Article 412, Radioactive Material Laboratory, DOE Radiological Control Manual. Provisions for these activities shall be clearly outlined in the SSHSP, if applicable.

5.7.6 Illumination

Illumination shall meet the requirements of Table H-120.1, 29 CFR 1910.120. Table III-6 lists OSHA-required illumination levels.

5.7.7 Sanitation

An adequate supply of potable water shall be provided at the site. Nonpotable water sources shall be clearly marked as not suitable for drinking or washing purposes.
At the remote sites (greater than 1 mile from TA-57), at least one toilet facility shall be provided.

5.7.8 Packaging and Transport

The OUPL will ensure that the requirements for storing and transporting hazardous materials are met and practices for storage, packaging, and transportation comply with ARs 10-2 and 10-3.

5.7.9 Government Vehicle Use

Only government vehicles can be driven onto contaminated sites. No personal vehicles are allowed.

5.7.10 Extended Work Schedules

Scheduled work outside normal work hours must have the prior approval of the OUPL and SSO. Due to the remote location of OU 1154, work schedules should not extend into times with less than full daylight, to allow for quick response for emergency personnel.

5.8 Permits

The following permits may be required for field activities:

- Excavation Permits
- Radiation Work Permits (only in the unlikely event that radioactive contamination is found)
- Special Work Permit for Spark/Flame-producing Operations
- Confined Space Entry Permits
- Lockout/Tagout Permits

The SSO and OUPL are responsible for obtaining permits and maintaining documentation. Permits are specifically addressed in the SSHSP.

6.0 PERSONAL PROTECTIVE EQUIPMENT

If engineering controls and work practices do not provide adequate protection against hazards, PPE may be required. For each operation included in the SSHSP, appropriate PPE will be designated. Use of PPE is required by OSHA regulations in 29 CFR Part 1910 Subpart I. Subcontractors are responsible for supplying PPE to their workers.
In addition, in the unlikely event that it is required, the use of PPE for radiological

protection shall be governed by the Radiation Work Permit (or Safety Work Permits/Radiation Work). AR 3-7 and Article 325, Article 461, Table 3.1, and Appendix 3C of the DOE Radiological Control Manual contain guidelines for the use of protective clothing (PC) during radiological operations.

6.1 Protective Equipment

Protective equipment, including protective eyewear and shoes, head gear, hearing protection, splash protection, lifelines, and safety harnesses, must meet American National Standards Institute standards.

6.2 Respiratory Protection Program

When engineering controls cannot maintain airborne contaminants at acceptable levels, appropriate respiratory protective measures shall be instituted. The Health and Safety Division administers the respiratory protection program, which defines respiratory protection requirements; verifies that personnel have met the criteria for training, medical surveillance, and fit testing; and maintains the appropriate records.

All supplemental workers shall submit documentation of participation in an acceptable respiratory protection program to the Industrial Hygiene Group (HS-5) for review and signature approval before using respirators on-site.

7.0 HAZARD CONTROLS

Hazard controls fall into two general categories: engineering controls and administrative controls. These controls will be used preferably over the use of personnel protective equipment (PPE) to control potential exposures.

7.1 Engineering Controls

OSHA regulations state that when possible engineering controls should be used as the first line of defense for protecting workers from hazards. Engineering controls are mechanical means for reducing hazards to workers, such as guarding moving parts of machinery and tools or using ventilation during confined space entry. Specific engineering controls appropriate for site conditions will be described in the SSHSP.

7.2 Administrative Controls

Administrative controls are necessary when hazards are present and engineering controls are not feasible. Administrative controls are a method for controlling the degree of exposure (e.g., how long or how close to the hazard the worker remains). Worker rotation shall not be used to achieve compliance with PELs or dose limits. Specific administrative controls will be presented in the SSHSP. The most important administrative control used will be limiting the number of people in the exclusion zone at each work area to the minimum required to safely complete the assigned tasks.

8.0 SITE MONITORING

A monitoring program or plan that meets the requirements of 29 CFR 1910.120 will be implemented for each OU. Laboratory-approved sampling, analytical, and recordkeeping methods must be used. A detailed monitoring strategy will be incorporated into each SSHSP. The strategy will describe the frequency, duration, and type of samples to be collected as well as the group or personnel responsible to conduct the sampling.

8.1 Chemical Air Contaminants

DOE has adopted OSHA PELs and ACGIH TLVs as standards for defining acceptable levels of exposure. The more stringent of the two limits applies.

8.1.1 Measurement

Measurements of chemical contaminants can be performed using direct or indirect sampling methods. Direct methods provide near real-time results and are often used as screening tools to determine levels of PPE, the need for additional sampling, etc. Indirect sampling means that a sample is collected in the field and transported to a laboratory for analysis. It will be up to the SSO to determine the most appropriate sampling method for each situation. If there are any questions about sampling methodology, the SSO should consult with the HSPL or a certified industrial hygienist.

8.1.2 Personal Monitoring

The site history should be used to determine the need for monitoring for specific chemical agents. Initial air monitoring shall be performed to characterize the exposure levels at the site and to determine the appropriate level of personal protection needed. Monitoring strategies will emphasize worst-case conditions if monitoring each individual is inappropriate.

8.1.3 Perimeter Monitoring

Perimeter monitoring shall be performed to characterize airborne concentrations in adjoining areas. If results indicate that contaminants are moving off-site, control measures must be re-evaluated. The perimeter is defined as the boundary of the work site.

8.2 Radiological Hazards

In the unlikely event that radiological hazards are known or suspected, workplace monitoring shall be performed as necessary to ensure that exposures are within the requirements of DOE Order 4380.11 and are as low as reasonably achievable (ALARA). Workplace monitoring consists of monitoring for airborne radioactivity, external radiation fields, and surface contamination. The Laboratory's workplace monitoring program is described in AR 3-7, Radiation Exposure Control.

8.3 Other Hazards

Other hazards, such as the noise hazard, will be monitored as appropriate. Monitoring for other hazards will be included in the SSHSP when those hazards are anticipated.

9.0 MEDICAL SURVEILLANCE AND MONITORING

A medical surveillance program shall be instituted to assess and monitor the health and fitness of workers engaged in HAZWOP. Medical surveillance is required for personnel who are or may be exposed to hazardous substances at or above established PELs for 30 days in a 12-month period, as detailed in 29 CFR 1910.120. Medical surveillance is also required for personnel with duties that require the use of respirators or with symptoms indicating possible overexposure to hazardous substances. Contractors are responsible for medical surveillance of their employees. The Health and Safety Division will audit contractor programs.

9.1 Medical Surveillance Program

All field team members who participate in ER Program investigations shall participate in a medical surveillance program. The program shall conform to DOE Order 5480.10, 29 CFR 1910.120, AR 2-1, and any criteria established by the Occupational Medicine Group (HS-2) at the Laboratory. The program shall provide for initial medical evaluations to determine fitness for duty and subsequent medical surveillance of individuals engaged in HAZWOP.

9.2 Emergency Treatment

In the event of an on-the-job injury, HS-2 will implement required reporting and recordkeeping procedures. The SSHSP describes the actions to be taken by the employee at the time of the injury/illness.

10.0 BIOASSAY PROGRAM

The OU RFI field characterization efforts will include intrusive investigations of areas of unknown but highly probable contamination potential. Given the uncertainties associated with this type of field work, the project internal exposure monitoring program is based on the assumption that personnel will be exposed to significant quantities of hazardous chemical contaminants. Accordingly, the bioassay program will be conducted in accordance with the provisions of HS-12.

11.0 DECONTAMINATION

Decontamination is the process of removing or neutralizing contaminants that have accumulated on personnel and equipment and is critical to health and safety at hazardous waste sites. Decontamination protects workers from hazardous substances that may contaminate PC, respiratory protection equipment, tools, vehicles, and other equipment used on-site. It minimizes the transfer of harmful materials into clean areas, helps prevent mixing of incompatible chemicals, and prevents uncontrolled transportation of contaminants from the site into the community. A site decontamination plan is mandatory. The site decontamination plan shall be part of the SSHSP and should follow the ER SOPs on personnel and equipment decontamination. At a minimum the plan shall include the step-by-step decontamination procedures to be used and diagrams showing how the decontamination stations will be arranged.

The decontamination plan should be revised whenever the type of personal PC or equipment changes, the site conditions change, or the site hazards are re-assessed based on new information.

11.1 Facilities

Clean areas shall be separate from contaminated areas and materials. For most of the OU 1154 field work, this will be accomplished by defining specific work zones for each site. The SSO will verify that decontamination facilities are maintained in acceptable condition and that supplies of decontaminating agents and other materials are available.

11.2 Personnel

The SSO is responsible for enforcing the decontamination plan. All personnel leaving the exclusion zone must be decontaminated to remove any chemical or infectious agents that may have adhered to them.

11.2.1 Radiological Decontamination

Personnel exiting contamination areas, high contamination areas, airborne radioactivity areas, or radiological buffer areas established for contamination control shall be frisked for contamination. This does not apply to personnel exiting areas containing only radionuclides, such as tritium, that cannot be detected using hand-held or automatic frisking equipment.

Personnel with detectable contamination on their skin or personal clothing, other than noble gases or natural background radioactivity, should be promptly decontaminated.

11.2.2 Chemical Decontamination

The decon nation of che y contaminated personnel will be detailed in the site decontam n plan.

11.3 Equipment Decontamination

Prior to release from the site, tools and equipment contaminated with removable radioactive and chemical materials in excess of applicable limits will be manually decontaminated at the field location.

11.4 Waste Management

Fluids and materials resulting from decontamination processes will be contained, sampled, and analyzed for contaminants. Those materials determined to be contaminated in excess of appropriate limits are packaged in approved containers and disposed of in accordance with Laboratory procedures.

The Laboratory will be responsible for characterization and disposal of chemical wastes generated by its subcontractors during site work under the ER Program.

12.0 EMERGENCIES

Emergency response, as defined by 29 CFR 1910.120, will be handled by Laboratory personnel. ER contractors are responsible for developing and implementing their own emergency action plans as defined in 29 CFR 1910.38. All emergency action plans must be consistent with Laboratory emergency response plans and should include specific procedures for dealing with site emergencies in an efficient manner. The emergency response Plans also must contain the following elements, as required by OSHA (29 CFR 1910.120 (3) (2)):

- pre-emergency planning including map of site to show layout.
- personnel roles, lines of authority, and communication.
- emergency recognition and prevention.
- safe distances and refuge.
- site security and control.
- evacuation routes and procedure.
- decontamination procedures not covered in the SSHSP.
- emergency medical treatment and first aid.
- emergency alerting and response procedures.
- critique of response and follow-up.

- PPE and emergency equipment.
- Procedures for reporting incidents to local, state, and federal governmental agencies, both for personnel injuries and property (including vehicle damage).

The SSO, with assistance from the field team leader, will have the responsibility and authority for coordinating all emergency response activities until the proper authorities arrive and assume control.

When an emergency occurs at the Laboratory, the Laboratory emergency response organization is responsible for all elements of response throughout the duration of the emergency.

The Laboratory Emergency Response Plan is designed to be compatible with emergency plans developed by local, state, tribal, and federal agencies through establishment of communications channels with these agencies and by setting criteria for the notification of each agency.

12.1 Emergency Action Plan

An emergency action plan provides emergency information for contingencies that may arise during the course of field operations. It provides site personnel with instructions for the appropriate sequence of responses in the event of either site emergencies or off-site emergencies. The emergency action plan will be attached to the SSHSP.

12.2 Provisions for Public Health and Safety

Emergency planning for public health and safety is presented in the Laboratory's ES&H Manual.

12.3 Notification Requirements

Field team members will notify the SSO of emergency situations; the SSO will notify the appropriate emergency assistance personnel (e.g., fire, police, and ambulance), the OUPL and the HSPL. The OUPL is responsible for contacting the Laboratory Health and Safety Division according to DOE Order 5500.2 and DOE Albuquerque Operations Office according to (AL) Order 5000.3. The Laboratory Health and Safety Division is responsible for implementing notification and reporting requirements according to DOE Order 5484.1 (DOE 1990, 0773).

12.4 Documentation

The Laboratory principal investigator will submit a completed DOE Form F 5484.X for any of the following accidents and incidents, according to Laboratory AR 1-1:

The HSPL will work with the OUPL and the field team leader to ensure that health and safety records are maintained with the appropriate Laboratory group, as required by DOE orders.

13.0 PERSONNEL TRAINING

Personnel training will be conducted following the field worker training requirements matrix. Additional training requirements and clarifications to the requirements matrix are discussed in the following subsections.

13.1 General Employee Training and Site Orientation

All Laboratory employees and supplemental workers must successfully complete Laboratory general employee training (GET).

Several types of training are required, including:

- OSHA-mandated,
- facility-specific,
- site-specific or pre-entry, and
- tailgate.

Site workers will receive each type of training during the course of field activities.

13.2 Site-Specific Training

This site-specific training will include input from TA-57 personnel as well as from the OU 1154 technical team. The expertise of the TA-57 personnel will be used to identify hazards particular to the site and to provide information on the site-specific emergency procedures. Prior to granting site access, personnel must be given site-specific training. Attendance and understanding of the site-specific training must be documented.

13.3 Radiation Safety Training

Basic radiation worker training is not required for site workers except in the unlikely event there are site workers (1) whose job assignments involve operation of radiation-producing devices, (2) who work with radioactive materials, (3) who are likely to be routinely occupationally exposed above 0.1 rem (0.001 sievert) per year, or (4) who require unescorted entry into a radiological area. This training is a 4-hour extension to GET for new employees.

13.4 Hazard Communication

Laboratory employees shall be trained in accordance with Health and Safety Division requirements. Contractors shall provide training to their employees in compliance with 29 CFR 1910.120.

13.5 Facility-Specific Training

Facility specific training will be conducted during the site-specific training as discussed in Section 13.2.

13.6 Records

Records of training shall be maintained by the Health and Safety Division and in the project file to confirm that every individual assigned to a task has had adequate training for that task and that every employee's training is up-to-date. The SSO or his designee is responsible for ensuring that persons entering the site are properly trained.

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Annex IV

Records Management Plan

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ANNEX IV RECORDS MANAGEMENT PROJECT PLAN

This work plan will follow the records management program plan provided in Annex IV of Revision 3 of the Installation Work Plan. (This sentence is the complete text of Annex IV.)

Annex V

Public Involvement Project Plan

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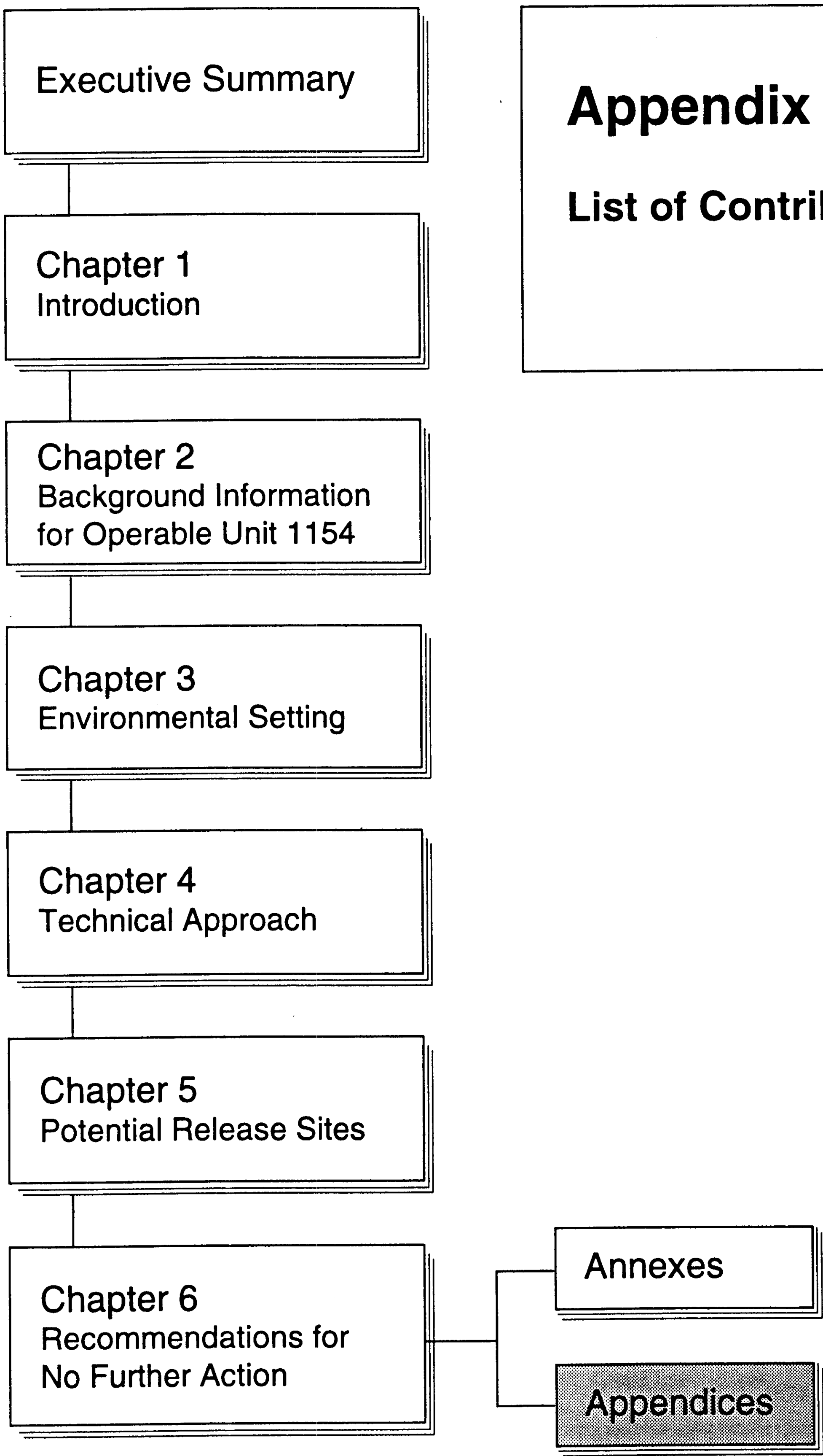
ANNEX V PUBLIC INVOLVEMENT PROJECT PLAN

This work plan will follow the community relations program plan provided in Annex V of Revision 3 of the Installation Work Plan. (This sentence is the complete text of Annex V).

Appendix A

List of Contributors



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Kerry Burns	PhD Geology Now retired, K. Burns was a researcher at the Laboratory from 1981-94. He has extensive experience in conducting surveys of earth resources for clients in all parts of the world.	Archives review, Chapters 1, 2, 3, and 5
Tracy Glatzmaier (EES-5)	B. S. Chemical Engineering, M.S. Industrial Engineering (Engineering Management Option) 8 years' experience in engineering and project management; data acquisition and analysis in atmospheric transport and diffusion; 4 years' management experience.	Operable Unit Project Leader
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Bart Vanden Plas (ERM/Golder)	M.S. Organic Chemistry 8 years' experience in chemistry including environmental industrial hygiene analysis, managing quality assurance programs, and development of sampling and analytical plans for environmental and industrial hygiene.	Chapter 4 and Annex II
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Glossary

GLOSSARY

Analytical levels Five levels describing the analytical options available to support data collection activities by distinguishing the types of technology and documentation used and their degree of sophistication.

Archival data Available information collected from published and unpublished records pertaining to the history or processes of potential release sites (PRSs). Records can include written communication such as reports, memoranda, letters, notes, or calculations. Verbal communication, if substantiated in writing or other independent testimony, can be considered as archival data.

Area of concern (AOC) A potential release site (PRS) that does not meet the HSWA Module's definition of a solid waste management unit (SWMU). These sites may contain radioactive materials and other substances not addressed by RCRA.

Background level The distribution of concentrations of naturally occurring or widely distributed constituents in environmental media.

Baseline risk assessment A risk assessment conducted using an appropriate site-specific exposure scenario but assuming no mitigating or corrective measures beyond those already in place. See also risk assessment.

Betatron A fixed radius electron accelerator.

CEARP (Comprehensive Environmental Assessment and Response Program) Created as an environmental cleanup program to fulfill DOE's obligations under several statutes and regulations.

CERCLA (Comprehensive Environmental Response, Compensation, and Liability Act of 1980 as amended by the Superfund Amendments and Reauthorization Act (SARA) of 1986) A federal law developed to clean up the nation's most hazardous abandoned waste sites. Because the Environmental Protection Agency (EPA) has determined that current conditions at the Laboratory do not pose an imminent threat to human health, the Laboratory is not listed on the National Priorities List (NPL) of abandoned facilities which require priority cleanup treatment.

Composite sample Formed by mixing a number of discrete samples taken at periodic points in time.

Conceptual exposure model A description of who might be exposed to contaminants of concern present at a PRS and how that exposure might occur.

Constituent Any compound or element present in environmental media, including both naturally occurring and anthropogenic elements.

Contaminant of concern (COC) Any constituent present in environmental media at a concentration above both its background level and its threshold level. COCs are organic, inorganic, or radioactive solids, liquids, or gases that, because of quantity, concentration, or physical/chemical characteristics, may cause or contribute to a threat to human health or the environment. Contaminants of concern may consist of one or more RCRA- or CERCLA-regulated constituents or of radioactive elements/daughter products.

Corrective measures implementation (CMI) A process that effects the chosen remedy, verifies its efficacy, and establishes ongoing control and monitoring requirements.

Corrective measures study (CMS) A process that evaluates the alternative remedies that might be reasonably implemented.

Corrosivity One of the four characteristics of hazardous waste. A hazardous waste is corrosive if it is aqueous and exhibits a pH less than 2 or greater than 12.5 or if it is a liquid which corrodes steel at a rate greater than 0.25 in. per year at 130^{o}F.

Data quality objectives (DQOs) Qualitative and quantitative statements developed before sampling begins to identify the quality of data that must be collected. DQOs define the specific role to be played by data in Phase I and Phase II decision making.

Decision logic A clear statement of what decision will be made about a PRS, of what actions will be taken as a result of this decision, and of exactly how data will be used to make the decision.

Decontamination and decommissioning (D&D) The removal of unwanted material (especially radioactive material) from the surface of or from within another material, and the removal from service of surface facilities and components necessary for preclosure activities only, after facility closure, in accordance with regulatory requirements and environmental policies.

Design criteria A statement of key factors that will be used in creating the sampling and analysis plan, including qualitative or quantitative criteria for limiting uncertainty in the decision.

Duplicate samples Two aliquots from one field sample submitted for laboratory analysis to demonstrate the reproducibility of the sampling procedure.

EPA SW-846 lab methods Test procedures which may be used to evaluate those properties of solids which determine whether the solids are hazardous wastes within the definition of Section 3001 of RCRA. These methods are approved for obtaining data to satisfy the requirement of 40 CFR Part 261, Identification and Listing of Hazardous Waste.

Exposure scenario A hypothetical situation describing how a receptor (a human) might be exposed to contaminants of concern present at a PRS.

Field blank Empty sample bottles prepared in the field using contaminant-free water following the general sampling procedures used in the field for collection of all waste samples and returned to the laboratory for analysis. Field blanks identify any contamination problems with the field sampling procedures.

Gas chromatography (GC) Method of trace analysis for organics.

Gross alpha radiation Total of alpha particle activities, normally measured for those emitters having energies above 3.9 megaelectronvolts, including background and any contribution from contamination.

Gross beta radiation Total of beta particle activities, normally measured for those emitters having energies above 0.1 megaelectronvolts, including background and any contribution from contamination.

Hazardous waste A solid waste, or combination of solid wastes, which, because of its quantity, concentration, or physical, chemical, or infectious characteristics, may cause, or significantly contribute to, an increase in mortality or an increase in serious irreversible or incapacitating reversible, illness; or pose a substantial present or potential hazard to human health or the environment when improperly treated, stored, transported, or disposed of, or otherwise managed.

Hollow-stem auger drilling Drilling method utilizing auger flights welded to hollow pipes with a cutting head attached to the lead auger. The method allows rapid advancement into unconsolidated materials to moderate depths. Samplers and drill pipe may be passed through the hollow pipe for sampling at discrete depths. Hollow stem augers may also be used as a temporary casing for rotary drilling or well construction.

HSWA RCRA's Hazardous and Solid Waste Amendments mandate that permits for treatment, storage, and disposal facilities include provisions for corrective action to mitigate releases from facilities currently in operation and to clean up contamination in areas designated as solid waste management units (SWMUs).

HSWA Module Prescribes a specific corrective action program for the Laboratory and provides the primary guidance for implementation of the Laboratory's Environmental Restoration Program. It defines the principal requirements with which DOE/UC must comply in implementing the ER Program at the Laboratory.

Human health risk Risk pertaining specifically to the health of the general public, as determined in accordance with RCRA guidance. Occupational exposures to Laboratory employees are addressed under other applicable or relevant and appropriate requirements (ARARs), not under the Environmental Protection Agency's (EPA's) guidelines for the general public.

Ignitability One of the four characteristics of hazardous waste. A hazardous waste is ignitable if it is a liquid which is less than 24% alcohol by volume, liquid which exhibits a flash point less than 140^{o} or a nonliquid which can cause a fire.

Indicator parameters Organic, inorganic, or radioactive solids, liquids, or gases that are characteristic of and provide a reliable indication of the presence of contamination. Indicator parameters are generally a subset of the potential contaminants of concern that may be present and are selected on the basis of their quantity, toxicity, mobility, and ease of detection.

Installation Work Plan (IWP) A Laboratory-wide master plan describing the system by which the Environmental Restoration Program will accomplish all RFIs and CMSs.

Isotope any two or more species of atoms of a chemical element with the same atomic number and position in the periodic table and nearly identical chemical behavior but with differing atomic mass or mass number and different physical properties.

Judgmental sampling An approach to sampling design which takes advantage of known factors (e.g., visible evidence of contamination, information about historical processes) to improve selection of the location and number of sampling points.

Maximum contaminant level (MCL) The highest concentration of a contaminant allowed in drinking water under the Safe Drinking Water Act (1986).

Metallography The study of the structure of metals and alloys by various methods, especially by optical and electron microscopes and by X-ray diffraction.

Metallurgy The science and technology of metals and alloys.

Method detection limit (MDL) The minimum concentration of a substance in the environmental medium of interest that can be identified, measured, and reported with 99 percent confidence that the concentration is greater than zero.

Mixed waste Waste that either is listed in Subpart D of 40 CFR Part 261 or exhibits any of the hazardous waste characteristics identified in Subpart C of 40 CFR Part 261.

No further action (NFA) One of the possible end points of the corrective action process: a decision that no further investigation or remediation is warranted for a PRS. NFA may be proposed during the RFI of a PRS if it is determined that no release with potentially significant risk to human health or the environment has occurred.

NPDES (National Pollutant Discharge Elimination System) Legislated by the Clean Water Act of 1977 to set forth and enforce effluent discharge limitation guidelines and standards. Permits are issued to municipal and industrial dischargers to ensure that pollutant discharges do not result in a violation of water quality standards.

Operable Unit (OU) Aggregates of SWMUs that will be addressed together for purposes of implementing cleanup.

Operable Unit Project Leader (OUPL) Responsible for managing the corrective action process for an operable unit.

Outfall The point of discharge of a pipe or drain to the environment.

Perched (water) Groundwater existing under saturated, unconfined conditions and separated from the main underlying groundwater body by an interval of unsaturated material.

Phase I The initial sampling phase of site assessment work intended to collect adequate information to confirm the presence or absence of contaminants of concern in environmental media. Phase I investigations may also include the gathering of geological, geophysical, and geochemical data considered necessary for modeling and other data analysis needs. Information collected during Phase I sampling and analysis will determine if Phase II sampling is necessary or may provide the basis for recommendations for NFA, DA, or VCA.

Phase II The second sampling phase of site assessment at PRSs that are known to have contaminants of concern, or that are known to require corrective measures, as determined on the basis of compelling historical information or site conditions or Phase I sampling investigations. Phase II sampling and analysis will help to determine the physical-chemical characteristics of the site and attempt to delineate the nature and extent of contamination. Data collected will be used for contaminant fate and transport modeling, risk assessments, treatability studies, and corrective measures studies, as required.

Potential release site (PRS) A location where contaminants of concern may have been released to environmental media. PRSs include both solid waste management units (SWMUs) and areas of concern (AOCs).

Practical quantitation limit (PQL) The lowest concentration of a substance in the environmental medium of interest that can be reliably determined within specified limits of precision and accuracy during routine laboratory operating conditions. PQLs are based on what is achievable for the average sample of a given type, such as soil, under average conditions.

RCRA (Resource Conservation and Recovery Act) A federal law that established a structure to track and regulate hazardous wastes from the time of generation to disposal. The hazardous waste provisions of RCRA govern the day-to-day operations of hazardous waste management, treatment, storage, and disposal (TSD) facilities. Under this law, the Laboratory qualifies as a treatment and storage facility and must have permits to operate.

RCRA facility investigation (RFI) Identifies the nature and extent of contamination at sources and in environmental pathways that could lead to exposure of human and environmental receptors.

RFI work plan to determine the nature and extent of releases of hazardous waste and hazardous constituents from PRSs.

RCRA wastes Waste that either is listed in Subpart D of 40 CFR Part 261 or exhibits any of the hazardous waste characteristics identified in Subpart C of 40 CFR Part 261. Characteristic or listed wastes defined in RCRA.

Reactivity One of the four characteristics of hazardous waste. a hazardous waste is reactive if it: is normally unstable; reacts violently with water; forms potentially explosive mixtures with water; when mixed with water, generates toxic gases, vapors, or fumes in quantity sufficient to present a danger to human health or the environment; is any chemical which will produce toxic gases between pH 2 and 12.5; or can detonate or is capable of an explosive reaction.

Risk assessment An assessment of the potential human health or environmental risk associated with contamination of environmental media. Risk assessment includes hazard identification, exposure assessment, and dose response analysis. For human health risk assessments, two endpoints are generally estimated: (1) excess lifetime cancer risk, and (2) noncarcinogenic toxicological impacts. See also baseline risk assessment.

Screening action level (SAL) Media-specific concentration levels for constituents derived using conservative criteria. The derivation of SALs is most often based on low risk under a very restrictive exposure scenario, but if an existing regulatory standard is lower than the value derived by this risk-based computation, it will be used for the SAL.

Settling tanks Concrete, metal-lined rectangular structures that are reservoirs for liquid waste once it has exited a building through a sump.

Site characterization The process of attaining a qualitative and quantitative understanding of the physical, chemical, and radiological environment at a site in sufficient detail to support risk assessments and evaluations of alternative remedial measures. Site characterization includes waste characterization, and may include performance assessments if radioactive contaminants of concern are present.

Solid waste management unit (SWMU) Any discernible unit at which solid wastes have been placed at any time, irrespective of whether it was intended for the management of solid or hazardous waste. Such units include any area at or around a facility at which solid wastes have been routinely and systematically released.

Source characterization Process by which hazardous constituents are identified and quantified.

Subsurface soil Soils more than 2 feet below the surface as specified in the EPA's interim final RFI guidance.

Sump A concrete depression trough at the lowest level in process and development building at Technical Area 9 (TA-9), and it facilitates drainage. It is located within the laboratory and receives liquid waste from experimental operations. At explosives facilities, drain lines and sumps are specially engineered to prevent settling of explosives in the drain system before reaching the settling tank. Large solids are collected before entering the waste system, while small solids are filtered out.

Surface soil For risk assessment purposes, soil in the upper 2 ft of earth as specified in the EPA's interim final RFI guidance.

Toxicity One of four waste characteristics (ignitability, corrosivity, reactivity, toxicity) that causes wastes not specifically identified by the EPA as hazardous to become classified as hazardous under RCRA.

Toxicity characteristic leaching procedure (TCLP) A method to identify wastes that are hazardous and thus subject to regulation under RCRA due to their potential to leach significant concentrations of specific toxic constituents.

Trip blank A contaminant-free sample prepared in the laboratory which travels with the empty sample bottles to the sampling site and returns to the laboratory with the samples. Trip blanks identify any problems of contamination in the preparation of the sample containers and shipping procedures.

Voluntary corrective action (VCA) Selection and implementation of an obvious and effective corrective action during or following the RCRA field investigation (RFI).

Waste can storage area A designated area or structure in which containers, usually metal cans or drums, are kept until they are collected and their contents disposed of according to established regulations.

Waste characterization The process of determining the qualitative and quantitative nature, magnitude, and extent of contamination by contaminants of concern at a site.